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(54) **MANAGEMENT SYSTEM AND MANAGEMENT METHOD**

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G06F 12/02 (2006.01)
G06F 3/06 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 12/02*** (2013.01); ***G06F 3/0608*** (2013.01); ***G06F 3/0647*** (2013.01); ***G06F 3/0683*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 3/0647; G06F 12/02
See application file for complete search history.

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(57) **ABSTRACT**

A management system manages a computer system having multiple storage apparatuses, which provide a virtual volume to a host. The computer system includes a pool, and the storage apparatus allocates a physical page in the pool to a write destination when writing to the virtual volume. The management system stores logical volume management information for managing a corresponding relationship between a storage apparatus in which a logical volume resides and a physical page forming the logical volume, and virtual volume management information for managing the corresponding relationship between a virtual segment in a virtual volume and a page allocated to the virtual segment, and based on the logical volume management information and the virtual volume management information identifies a first page migration, which is affected in a case where either a determination-target storage apparatus is stopped or a first storage area is blocked, and displays the first page migration information.

15 Claims, 29 Drawing Sheets

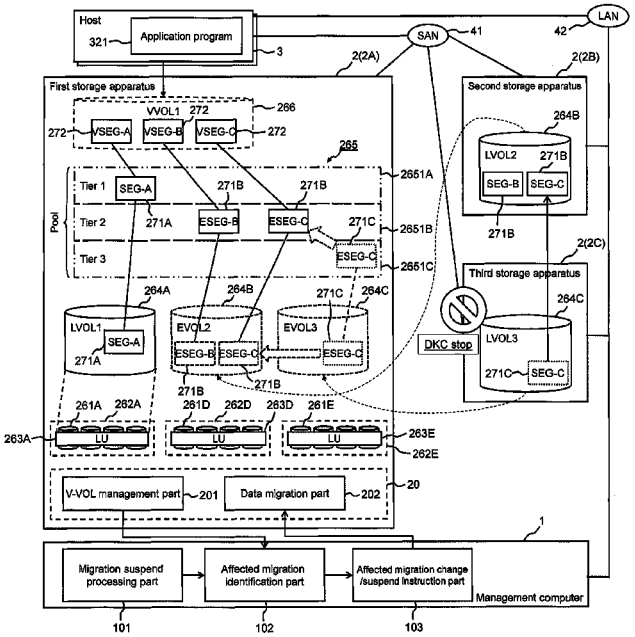


Fig. 1

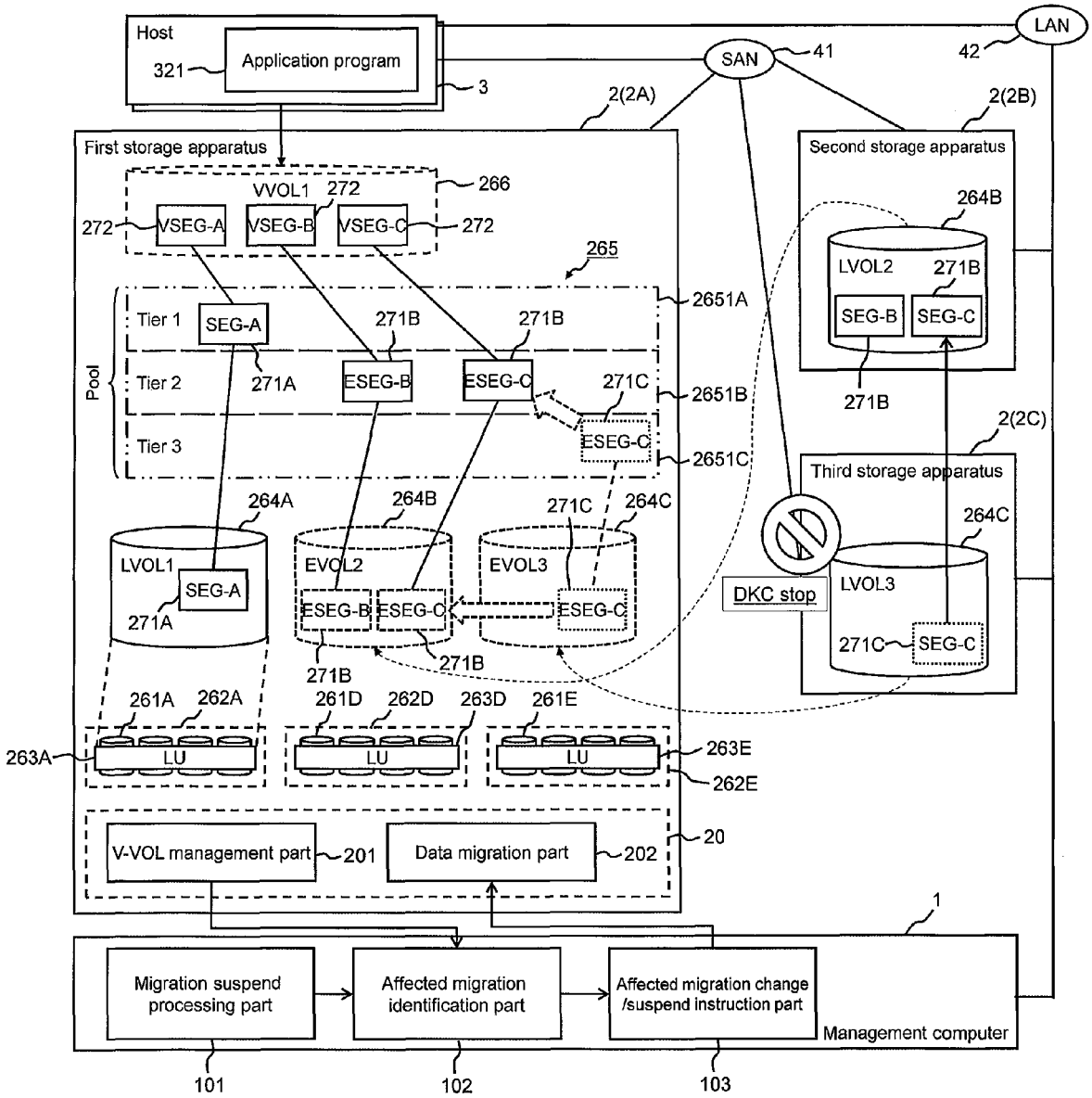

Host
Application program
321
3
LAN
42
SAN
41
2(2A)
2(2B)
First storage apparatus
Second storage apparatus
VVOL1
272
266
VSEG-A
VSEG-B
VSEG-C
265
Tier 1
Tier 2
Tier 3
Pool
SEG-A
271A
271B
ESEG-B
ESEG-C
271C
2651A
2651B
2651C
264A
264B
264C
LVOL1
EVOL2
EVOL3
LVOL2
LVOL3
SEG-B
SEG-C
DKC stop
2(2C)
Third storage apparatus
261A
262A
261D
262D
263D
261E
263A
263E
262E
LU
V-VOL management part
201
Data migration part
202
20
1
Migration suspend processing part
Affected migration identification part
Affected migration change /suspend instruction part
Management computer
101
102
103

Fig. 2

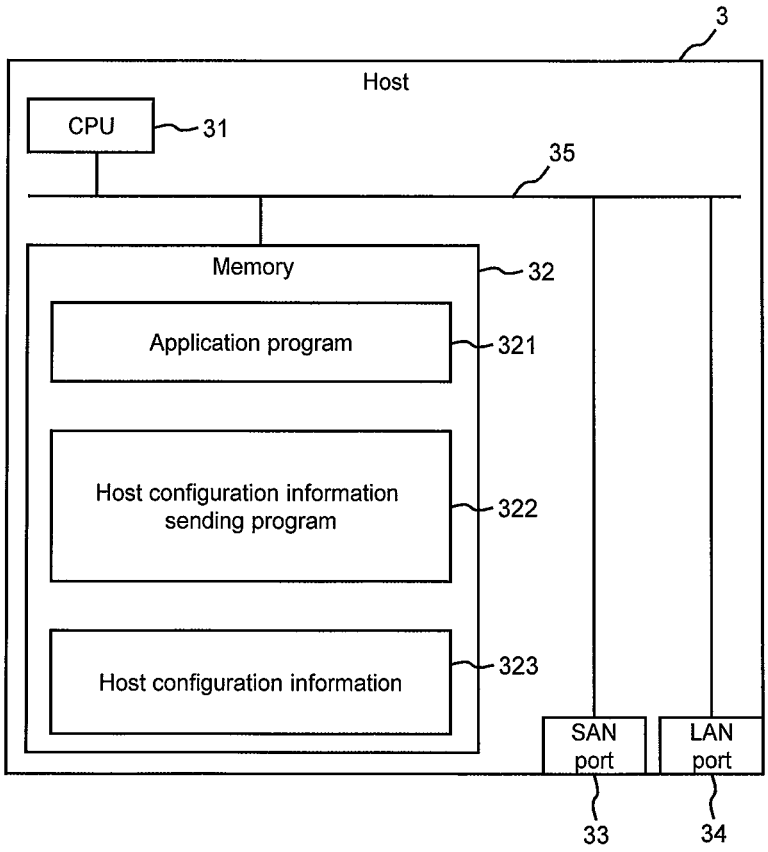

3
Host
CPU
31
35
Memory
32
Application program
321
Host configuration information sending program
322
Host configuration information
323
SAN port
LAN port
33
34

Fig. 3

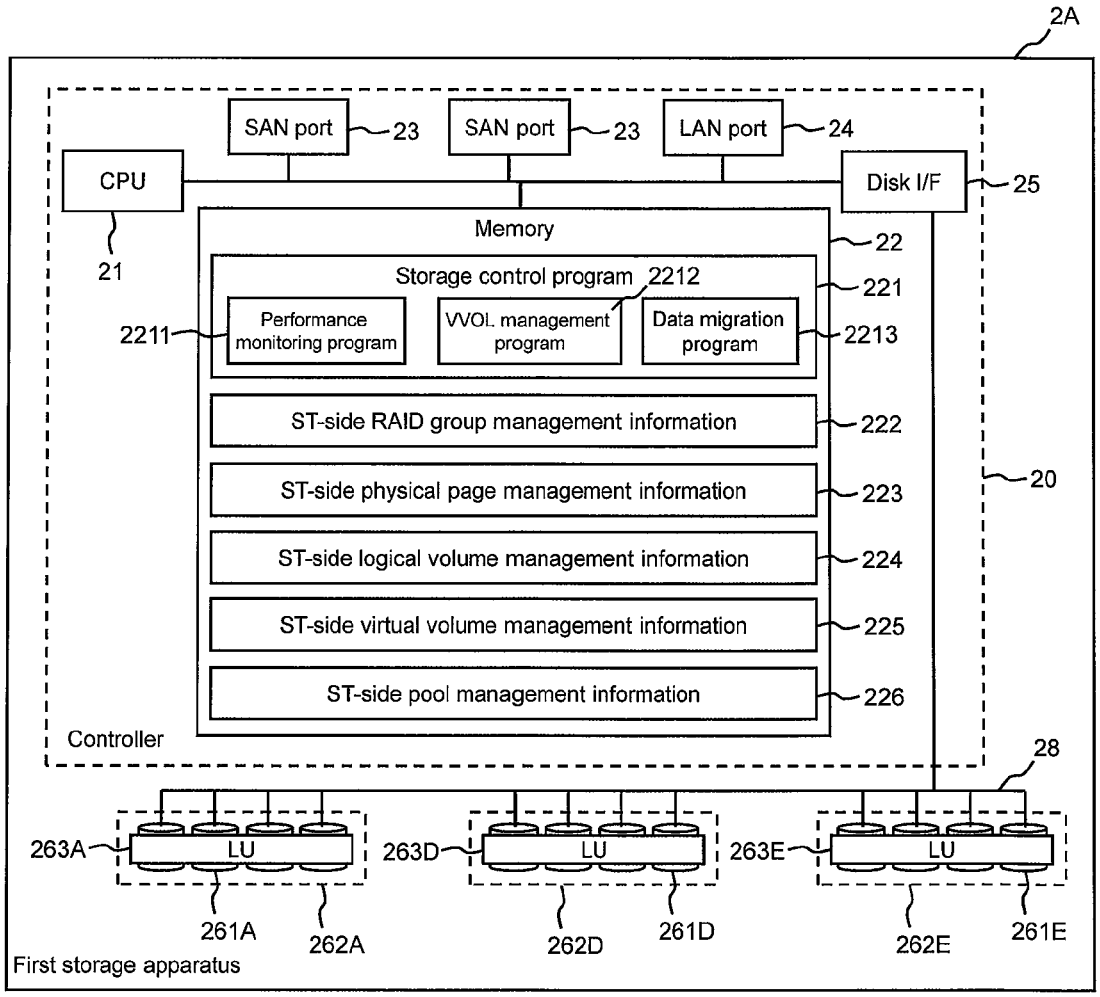

2A
SAN port
23
SAN port
23
LAN port
24
CPU
Disk I/F
25
21
Memory
22
Storage control program
2212
221
2211
Performance monitoring program
VVOL management program
Data migration program
2213
ST-side RAID group management information
222
ST-side physical page management information
223
20
ST-side logical volume management information
224
ST-side virtual volume management information
225
ST-side pool management information
226
Controller
28
263A
LU
263D
LU
263E
LU
261A
262A
262D
261D
262E
261E
First storage apparatus

Fig. 4

222

ST-side RAID group management information

2221 RAID group ID	2222 Device type	2223 RAID level	2224 PDEV-ID
RG1	SSD	RAID5(3D+1P)	PDEV1
			PDEV2
			PDEV3
			PDEV4
RG2	FC	RAID5(3D+1P)	PDEV5
			PDEV6
			PDEV7
			PDEV8
RG3	SATA	RAID0	PDEV9
			PDEV10
...	...	...	...

Fig. 5

223

ST-side physical page management information

2231 RAID group ID	2232 Physical page ID	2233 RAID group LBA range	2234 Allocation status
RG1	SEG1	0-999	Allocated
	SEG2	1000-1999	Allocated
	SEG3	2000-2999	Allocated
RG2	SEG4	0-999	Allocated
	SEG5	1000-1999	Unallocated
RG3	SEG6	0-999	Allocated
	SEG7	1000-1999	Unallocated
...	...	...	...

Fig. 6

224

ST-side logical volume management information

2241 LVOL-ID	2242 Real segment ID	2243 External storage apparatus ID	2244 Mapping-source LVOL-ID	2245 Mapping-source physical page ID
LVOL1	SEG1	n/a	n/a	n/a
	SEG2			
	SEG3			
EVOL2	ESEG1	ST2	LVOL2	SEG1
EVOL3	ESEG2	ST3	LVOL3	SEG2
...	...	...	...	...

Fig. 7

225

ST-side virtual volume management information

2251 VVOL-ID	2252 Virtual segment ID	2253 VVOL LBA range	2254 Segment ID	2255 Number of accesses	2256 Monitoring period	2257 Reallocation destination determination result
VVOL1	VSEG1	0-999	SEG1	28800	0:00−23:59	Tier1
	VSEG2	1000-1999	ESEG1	68400	0:00−23:59	Tier2
	VSEG3	2000-2999	ESEG2	12960	0:00−23:59	Tier3
VVOL2	VSEG4	0-999	SEG2	111600	0:00−23:59	Tier2
VVOL3	VSEG5	0-999	SEG3	158400	0:00−23:59	Tier3
...	...	...	...	...	...	...

Fig. 8

226

ST-side pool management information

2261 Pool-ID	2262 Pool configuration LVOL-ID	2263 Storage apparatus	2264 Inter-tier page migration	2265 Migration cycle	2266 Monitoring time period
P1	LVOL1	ST1	ON	1Day	00:00−23:59
	EVOL2	ST2			
	EVOL3	ST3			
P2	LVOL2	ST1	OFF	n/a	n/a
...	...	...	...	...	...

Fig. 9

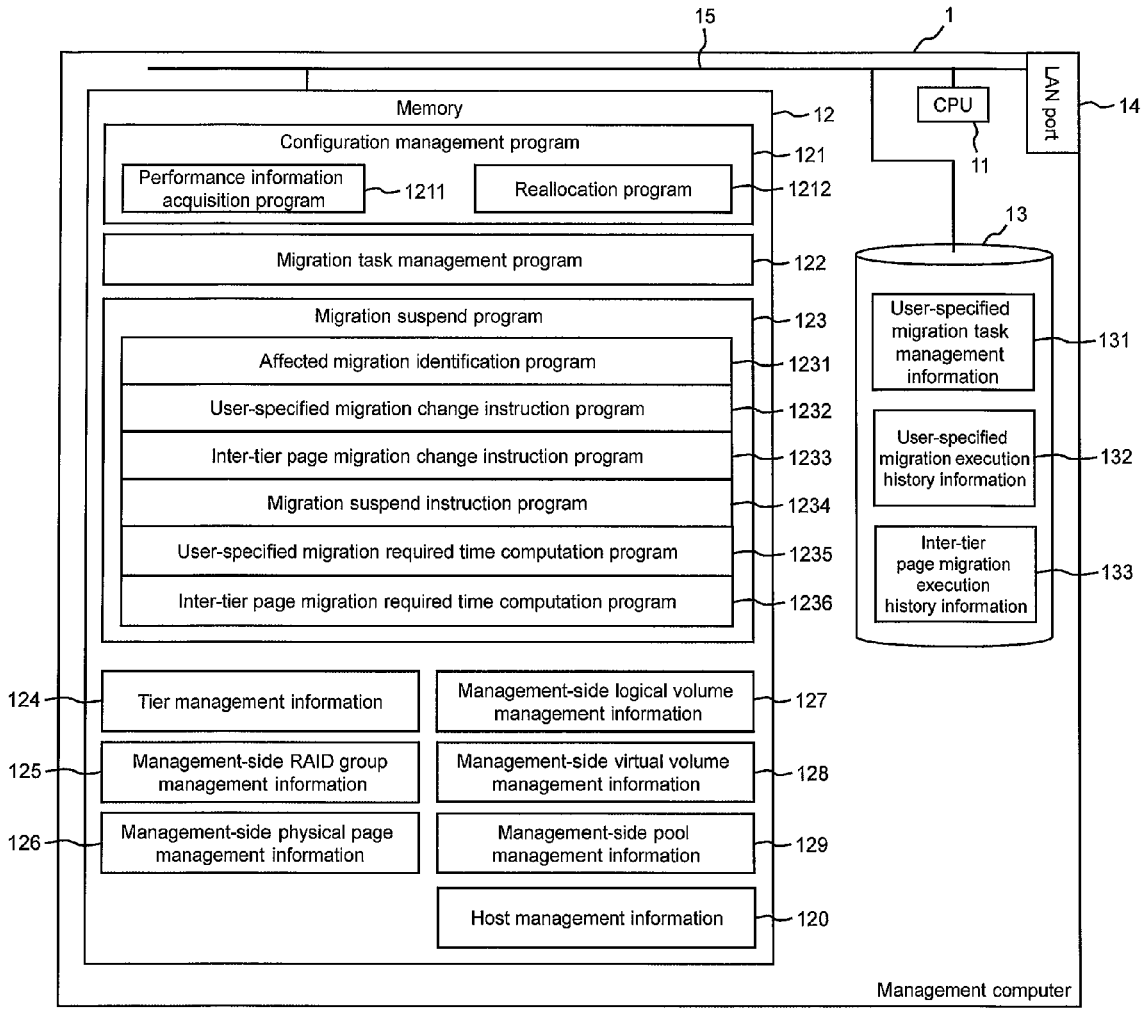

15
1
Memory
12
Configuration management program
121
Performance information acquisition program
1211
Reallocation program
1212
Migration task management program
122
Migration suspend program
123
Affected migration identification program
1231
User-specified migration change instruction program
1232
Inter-tier page migration change instruction program
1233
Migration suspend instruction program
1234
User-specified migration required time computation program
1235
Inter-tier page migration required time computation program
1236
CPU
11
LAN port
14
13
User-specified migration task management information
131
User-specified migration execution history information
132
Inter-tier page migration execution history information
133
124
Tier management information
125
Management-side RAID group management information
126
Management-side physical page management information
Management-side logical volume management information
127
Management-side virtual volume management information
128
Management-side pool management information
129
Host management information
120
Management computer

Fig. 10

125

Management-side RAID group management information

1251 RAID group ID	1252 Storage apparatus ID	1253 Device type	1254 RAID level
RG1	ST1	SSD	RAID5(3D+1P)
RG2		FC	RAID5(3D+1P)
RG3		SATA	RAID0
RG1	ST2	SATA	RAID5(4D+1P)
...	...	...	...

Fig. 11

128

Management-side virtual volume management information

1281 VVOL-ID	1282 Storage apparatus ID	1283 Virtual segment ID	1284 VVOL LBA range	1285 Real segment ID	1286 IOPS	1287 Reallocation destination determination result
VVOL1	ST1	VSEG1	0-999	SEG1	8	Tier1
		VSEG2	1000-1999	ESEG1	19	Tier2
		VSEG3	2000-2999	ESEG2	3.6	Tier3
VVOL2		VSEG4	0-999	SEG2	31	Tier2
VVOL3		VSEG5	0-999	SEG3	44	Tier3
VVOL4	ST4	VSEG5	0-999	SEG1	30	Tier2
...	...	...	...	...	...	...

Fig. 12

124

Tier management information

1241 Storage apparatus ID	1242 Tier ID	1243 Performance condition	1244 Allocation condition (IOPS)
ST1	Tier1	Device type = SSD, RAID level = RAID5	Equal to or larger than 100
	Tier2	Device type = FC, RAID level = RAID5	Equal to or larger than 30 but less than 100
	Tier3	Device type = SATA, external volume	Less than 30
ST4	...	...	...

Fig. 13

120

Host management information

1201 Host	1202 Allocated volume	1203 Storage apparatus
Host 1	VVOL1	ST1
Host 2	...	...
Host 3	...	...

Fig. 14

131

User-specified migration task management information

1311 Task ID	1312 Migration -source volume	1313 Migration-source storage apparatus	1314 Migration -destination volume	1315 Migration -destination storage apparatus	1319 Sub-task status	1316 Task status	1317 Execution start date/time	1318 Execution complete date/time
VM1	LVOL1	ST1	LVOL10	ST2	Normal completion	Executing	2012/1/4 10:00	...
	LVOL2		LVOL11		Executing			
	LVOL3		LVOL12		Waiting			
VM2	EVOL	ST1	LVOL4	ST1	Waiting	Waiting	2012/2/1 00:30	...
...	...	...	...	...	...	...	...	...

Fig. 15

132

User-specified migration execution history information

1321 Storage apparatus ID	1322 Total value of execution time periods	1323 Total value of migration data amounts
ST1	10 hours 20 minutes 54 seconds	842.45 GB
ST2	...	...
ST3	...	...

Fig. 16

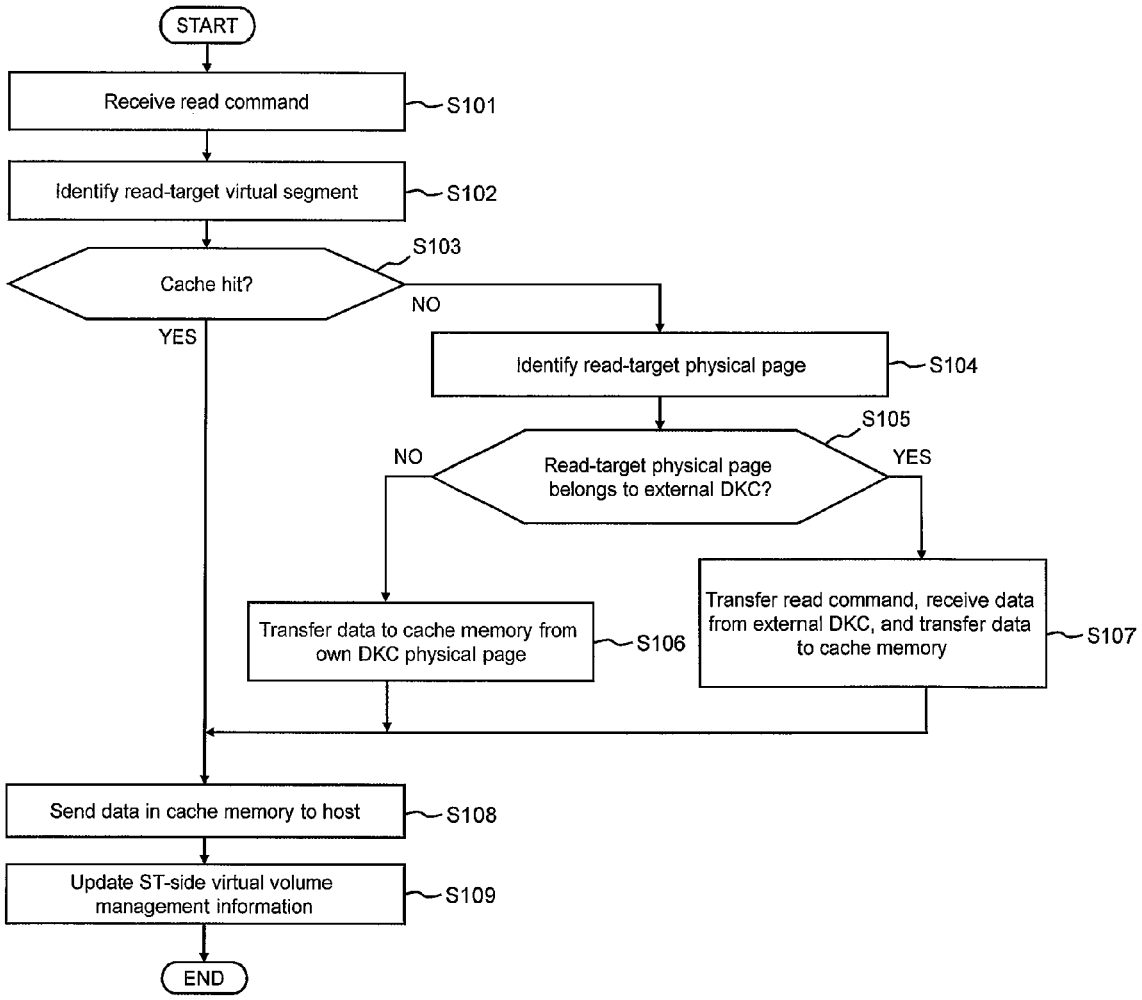

START
Receive read command
S101
Identify read-target virtual segment
S102
Cache hit?
S103
NO
YES
Identify read-target physical page
S104
Read-target physical page belongs to external DKC?
S105
NO
YES
Transfer data to cache memory from own DKC physical page
S106
Transfer read command, receive data from external DKC, and transfer data to cache memory
S107
Send data in cache memory to host
S108
Update ST-side virtual volume management information
S109
END

Fig. 17

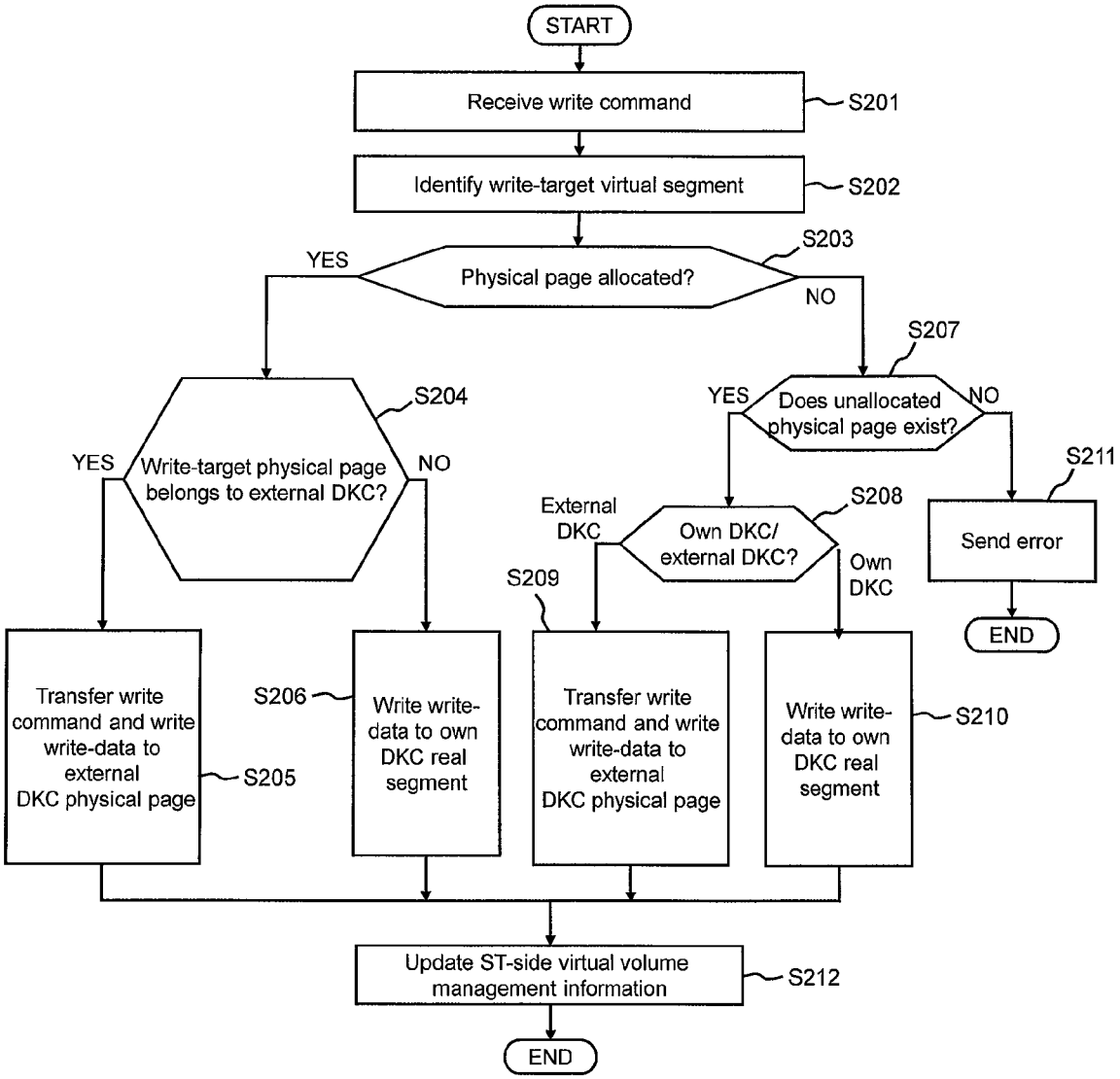

START
Receive write command
S201
Identify write-target virtual segment
S202
S203
YES
Physical page allocated?
NO
S207
YES
Does unallocated physical page exist?
NO
S204
YES
Write-target physical page belongs to external DKC?
NO
S211
External DKC
S208
Own DKC/ external DKC?
Own DKC
Send error
END
S209
Transfer write command and write write-data to external DKC physical page
S205
S206
Write write-data to own DKC real segment
Transfer write command and write write-data to external DKC physical page
Write write-data to own DKC real segment
S210
Update ST-side virtual volume management information
S212
END

Fig. 18

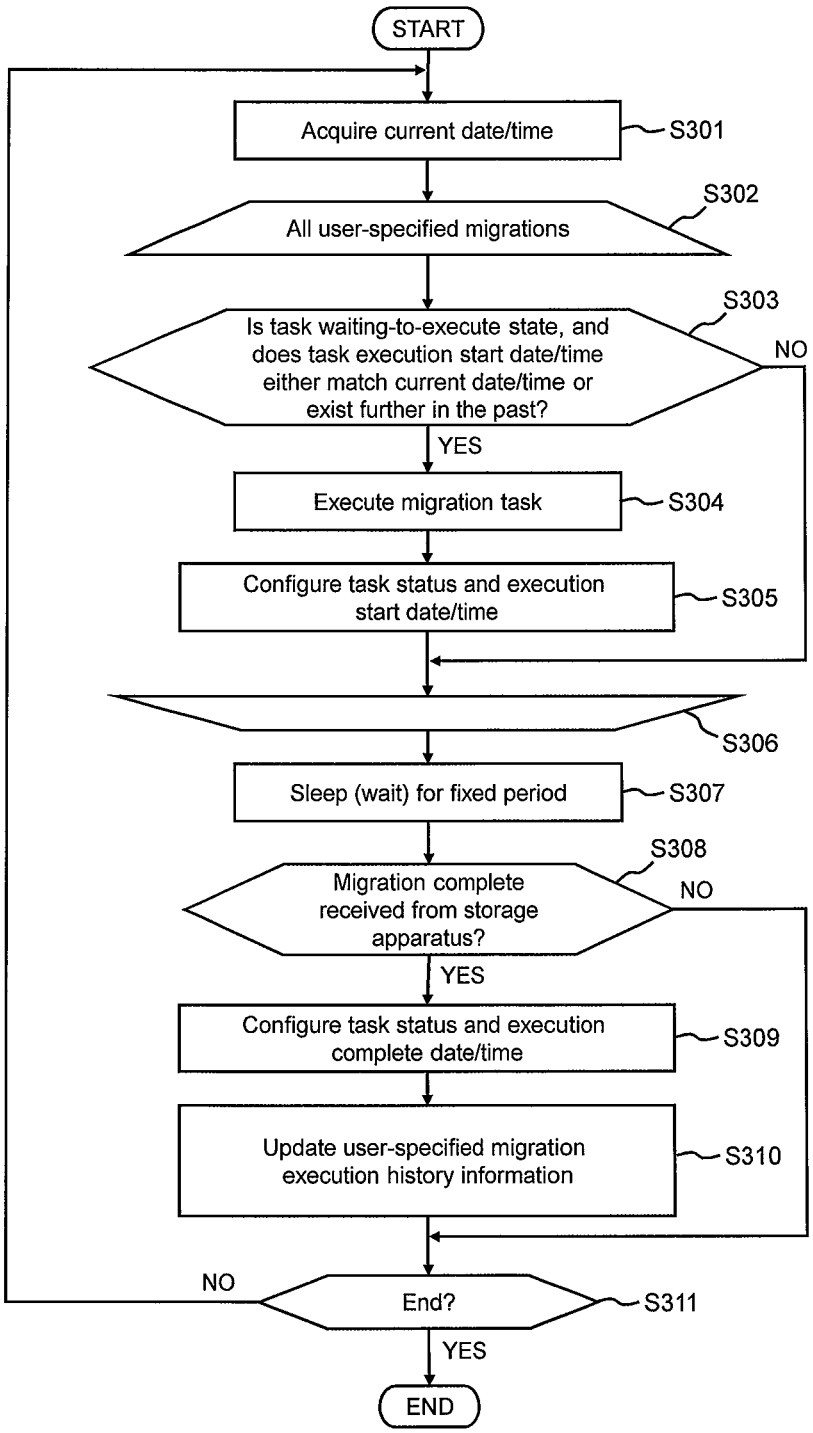

START
Acquire current date/time
S301
S302
All user-specified migrations
S303
Is task waiting-to-execute state, and does task execution start date/time either match current date/time or exist further in the past?
NO
YES
Execute migration task
S304
Configure task status and execution start date/time
S305
S306
Sleep (wait) for fixed period
S307
S308
Migration complete received from storage apparatus?
NO
YES
Configure task status and execution complete date/time
S309
Update user-specified migration execution history information
S310
NO
End?
S311
YES
END

Fig. 19

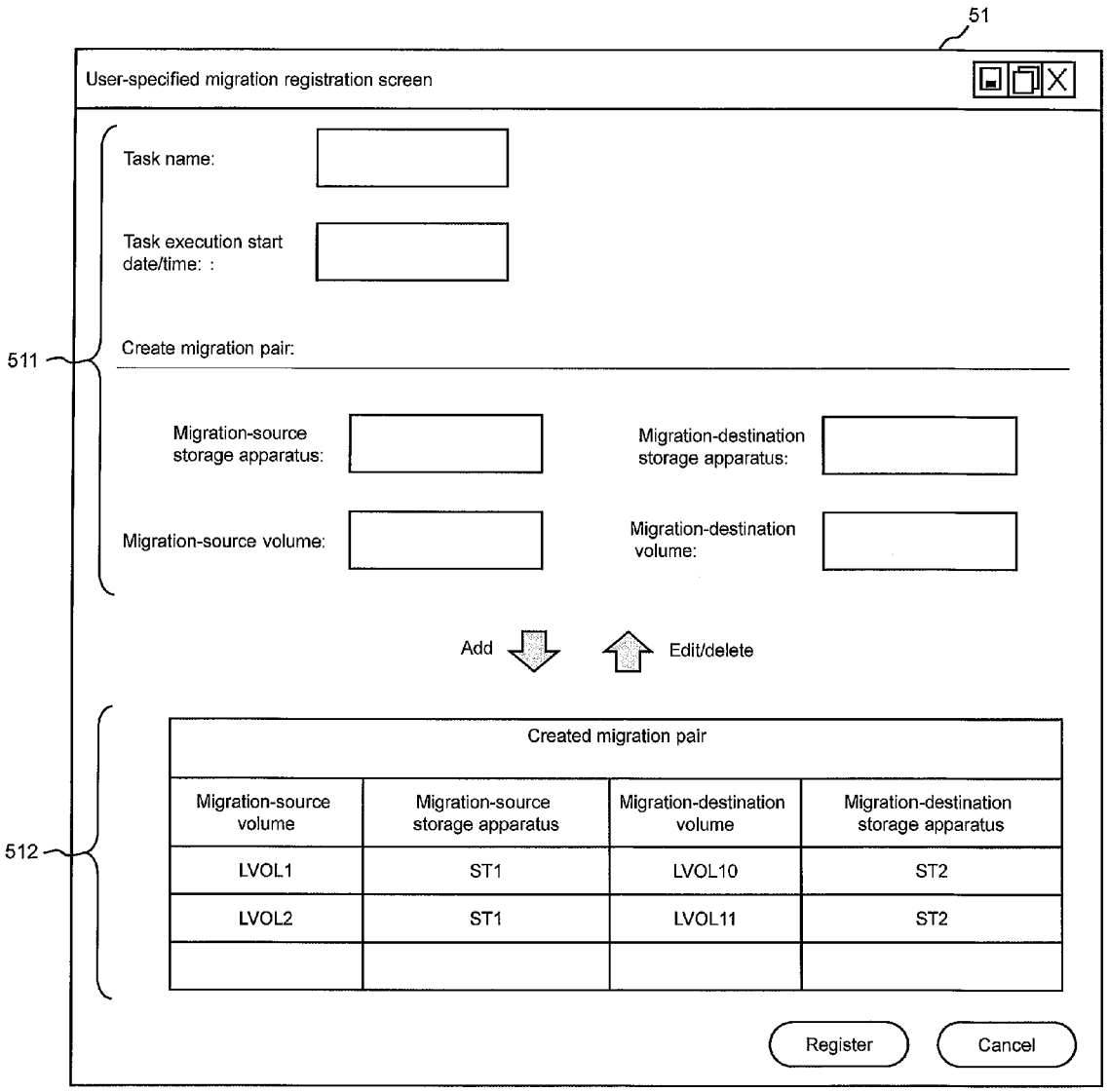

51
User-specified migration registration screen
Task name:
Task execution start date/time: :
511
Create migration pair:
Migration-source storage apparatus:
Migration-destination storage apparatus:
Migration-source volume:
Migration-destination volume:
Add
Edit/delete
512
Created migration pair
Migration-source volume
Migration-source storage apparatus
Migration-destination volume
Migration-destination storage apparatus
LVOL1
ST1
LVOL10
ST2
LVOL2
ST1
LVOL11
ST2
Register
Cancel

Fig. 20

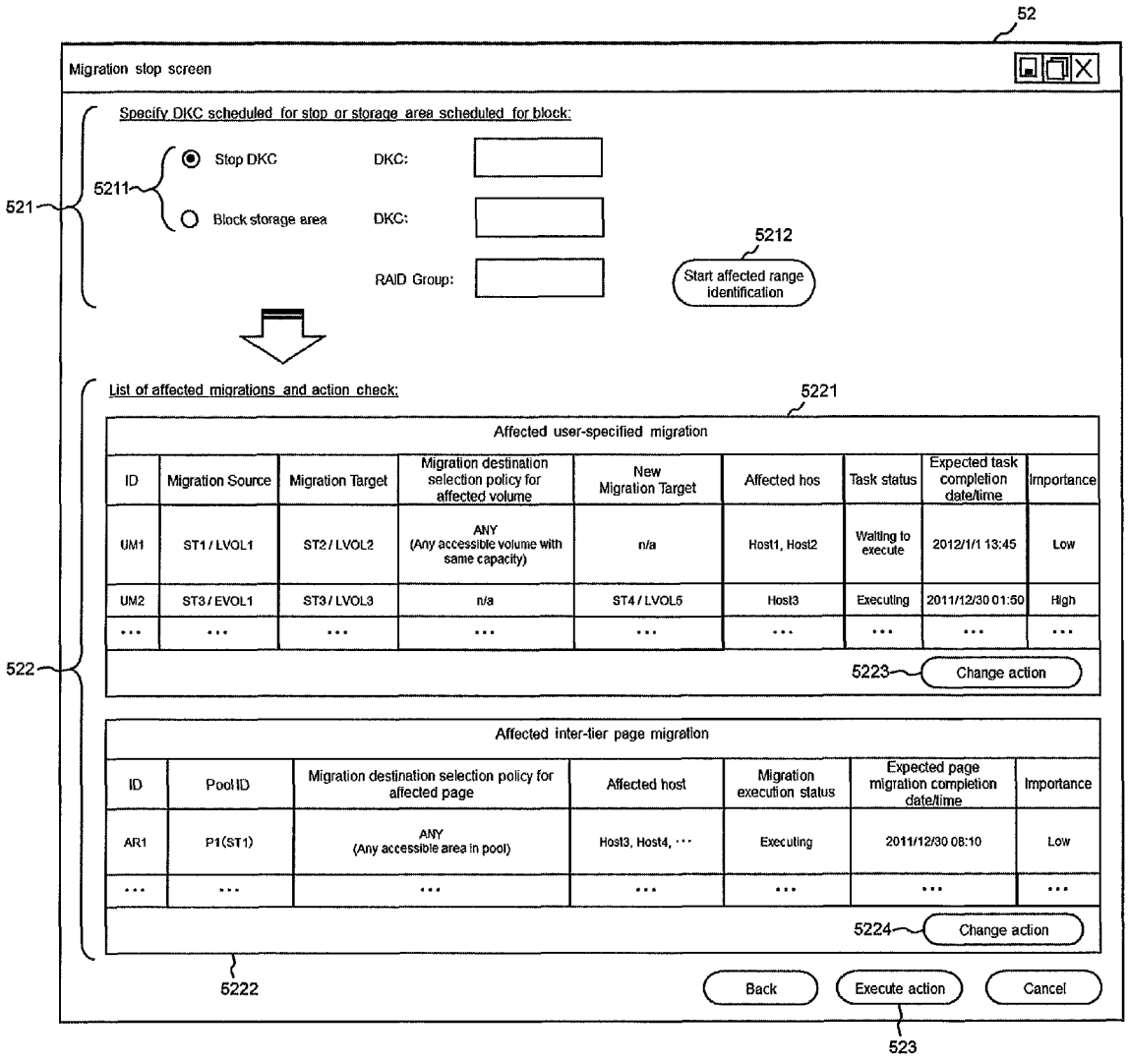

52
Migration stop screen
Specify DKC scheduled for stop or storage area scheduled for block:
521
5211
Stop DKC
DKC:
Block storage area
DKC:
RAID Group:
5212
Start affected range identification
List of affected migrations and action check:
5221
Affected user-specified migration
ID
Migration Source
Migration Target
Migration destination selection policy for affected volume
New Migration Target
Affected hos
Task status
Expected task completion date/time
Importance
UM1
ST1 / LVOL1
ST2 / LVOL2
ANY (Any accessible volume with same capacity)
n/a
Host1, Host2
Waiting to execute
2012/1/1 13:45
Low
UM2
ST3 / EVOL1
ST3 / LVOL3
n/a
ST4 / LVOL5
Host3
Executing
2011/12/30 01:50
High
522
5223
Change action
Affected inter-tier page migration
ID
Pool ID
Migration destination selection policy for affected page
Affected host
Migration execution status
Expected page migration completion date/time
Importance
AR1
P1 (ST1)
ANY (Any accessible area in pool)
Host3, Host4, ···
Executing
2011/12/30 08:10
Low
5224
Change action
5222
Back
Execute action
Cancel
523

Fig. 21

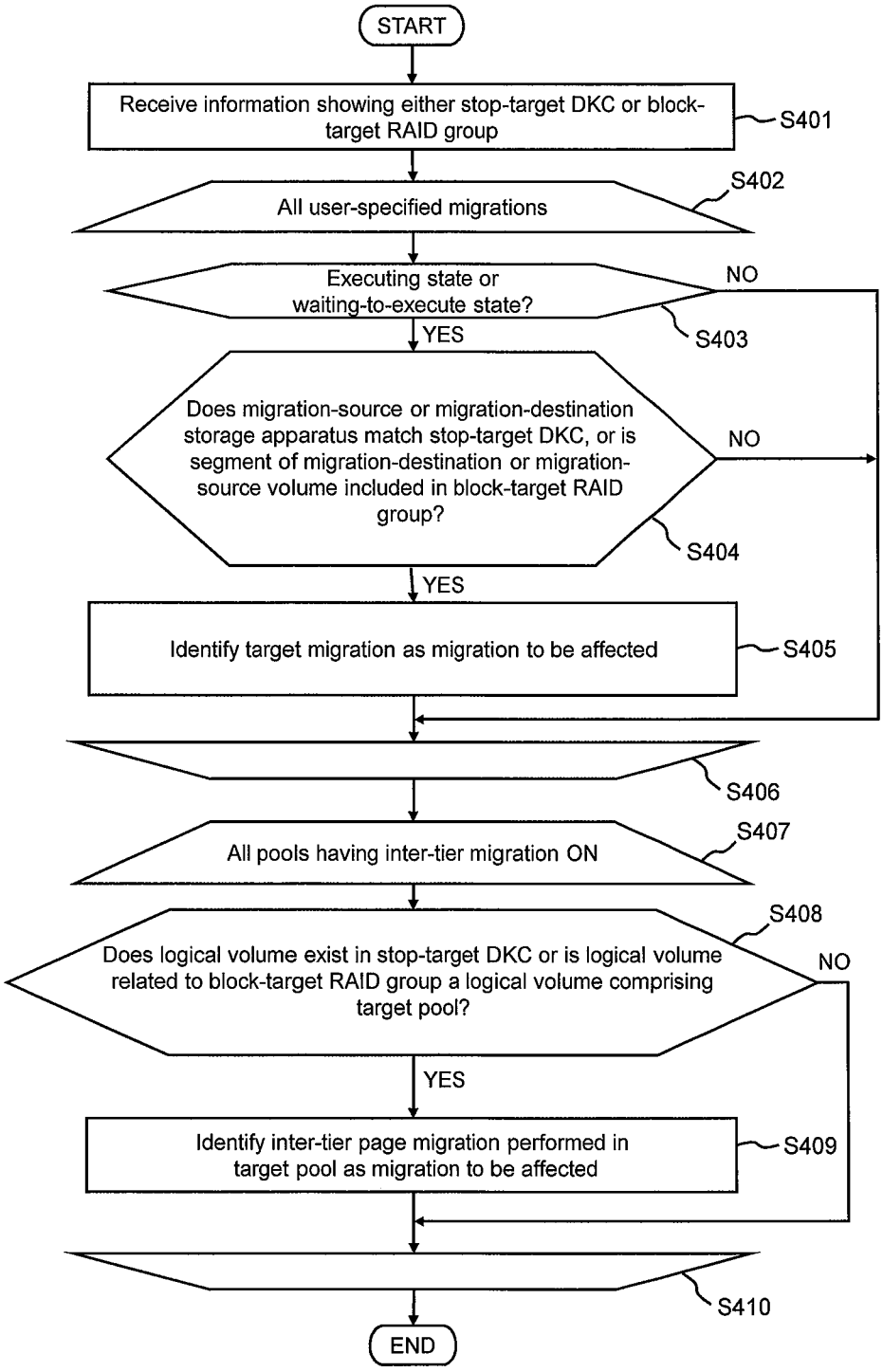

START
Receive information showing either stop-target DKC or block-target RAID group
S401
All user-specified migrations
S402
Executing state or waiting-to-execute state?
NO
S403
YES
Does migration-source or migration-destination storage apparatus match stop-target DKC, or is segment of migration-destination or migration-source volume included in block-target RAID group?
NO
S404
YES
Identify target migration as migration to be affected
S405
S406
All pools having inter-tier migration ON
S407
Does logical volume exist in stop-target DKC or is logical volume related to block-target RAID group a logical volume comprising target pool?
S408
NO
YES
Identify inter-tier page migration performed in target pool as migration to be affected
S409
S410
END

Fig. 22

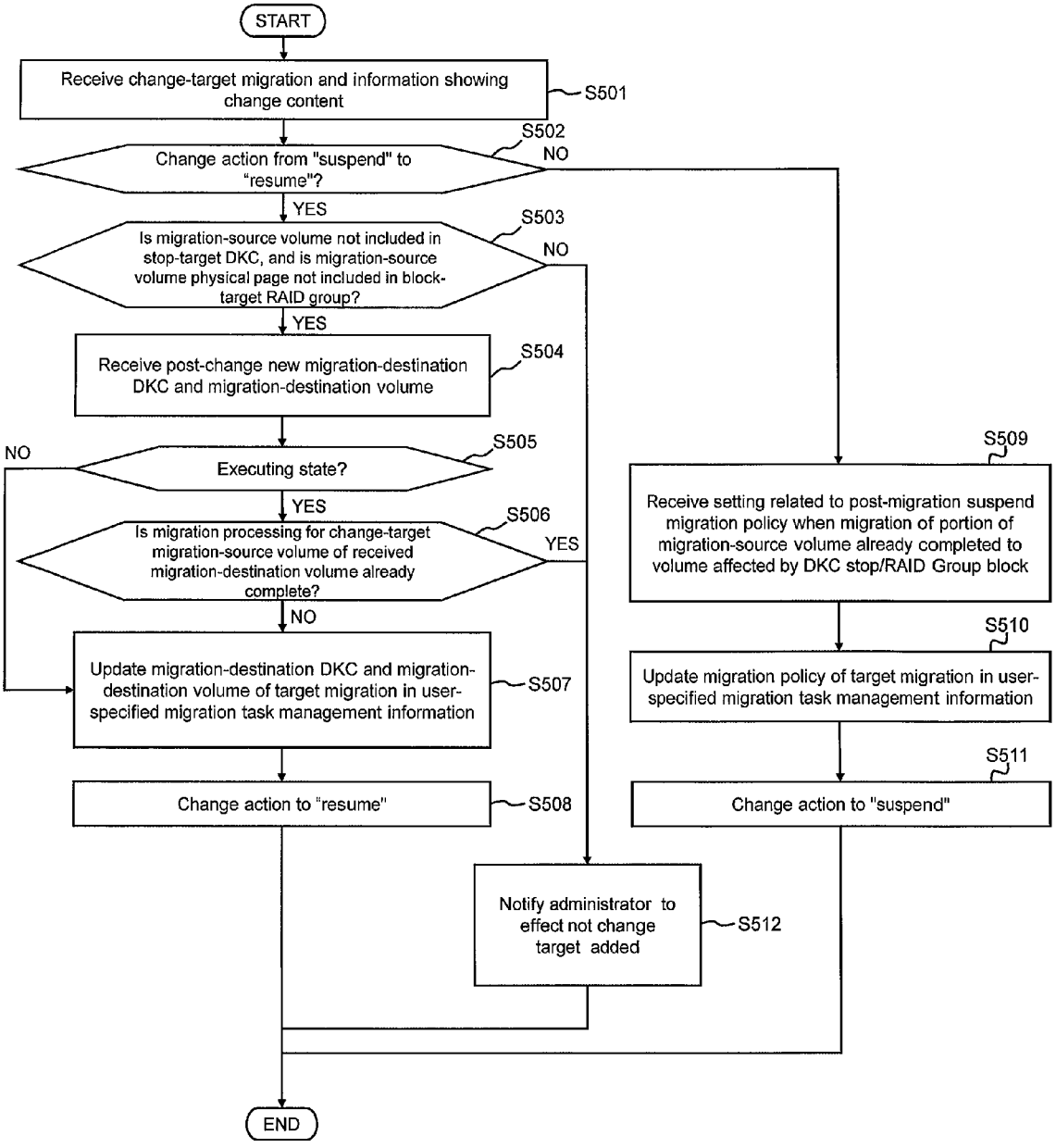

START
Receive change-target migration and information showing change content
S501
S502
Change action from "suspend" to "resume"?
NO
YES
S503
Is migration-source volume not included in stop-target DKC, and is migration-source volume physical page not included in block-target RAID group?
NO
YES
Receive post-change new migration-destination DKC and migration-destination volume
S504
NO
S505
Executing state?
YES
S506
Is migration processing for change-target migration-source volume of received migration-destination volume already complete?
YES
NO
Update migration-destination DKC and migration-destination volume of target migration in user-specified migration task management information
S507
Change action to "resume"
S508
S509
Receive setting related to post-migration suspend migration policy when migration of portion of migration-source volume already completed to volume affected by DKC stop/RAID Group block
S510
Update migration policy of target migration in user-specified migration task management information
S511
Change action to "suspend"
Notify administrator to effect not change target added
S512
END

Fig. 23

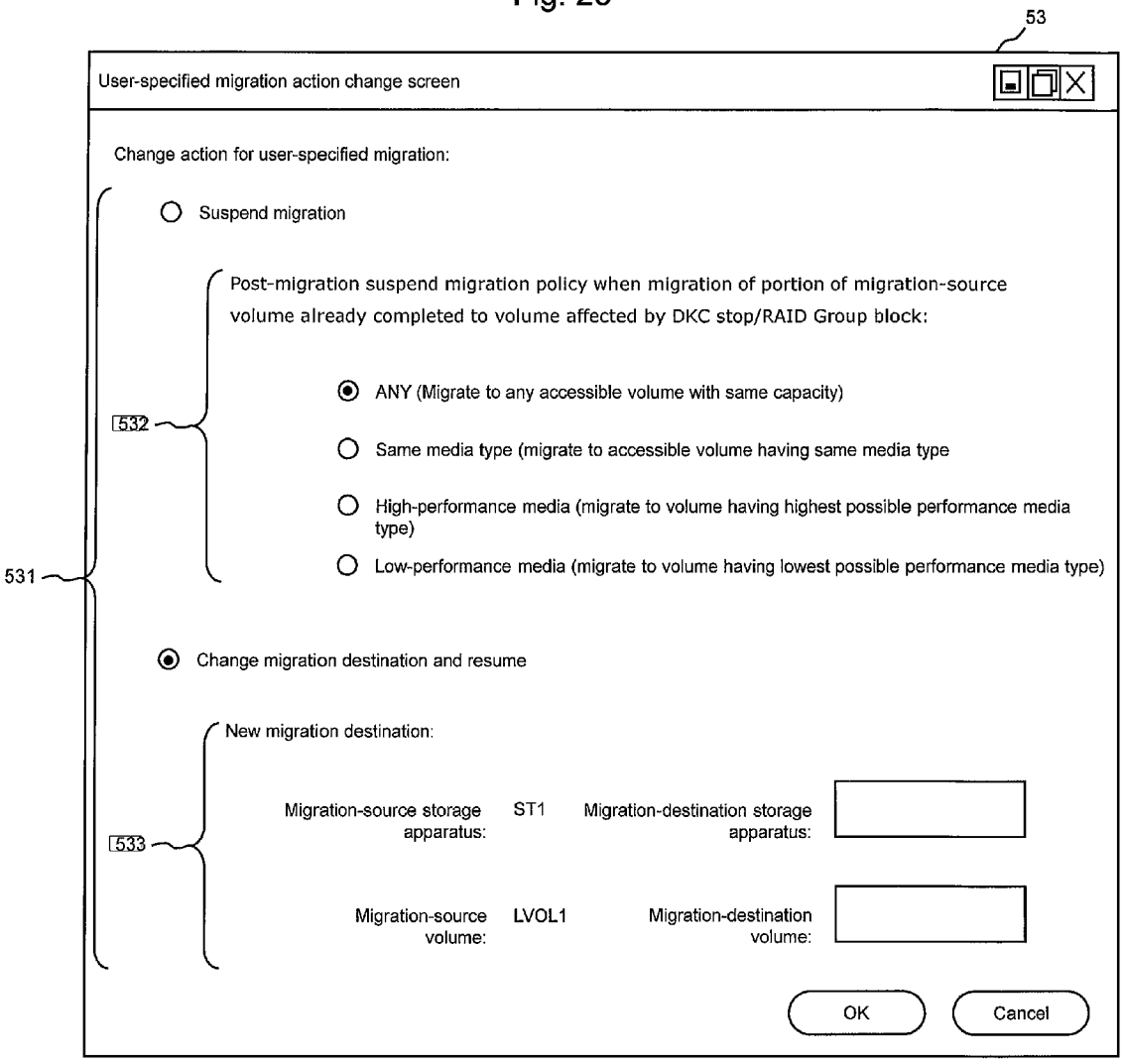

53
User-specified migration action change screen
Change action for user-specified migration:
Suspend migration
Post-migration suspend migration policy when migration of portion of migration-source volume already completed to volume affected by DKC stop/RAID Group block:
532
ANY (Migrate to any accessible volume with same capacity)
Same media type (migrate to accessible volume having same media type
High-performance media (migrate to volume having highest possible performance media type)
Low-performance media (migrate to volume having lowest possible performance media type)
531
Change migration destination and resume
New migration destination:
533
Migration-source storage apparatus:
ST1
Migration-destination storage apparatus:
Migration-source volume:
LVOL1
Migration-destination volume:
OK
Cancel

Fig. 24

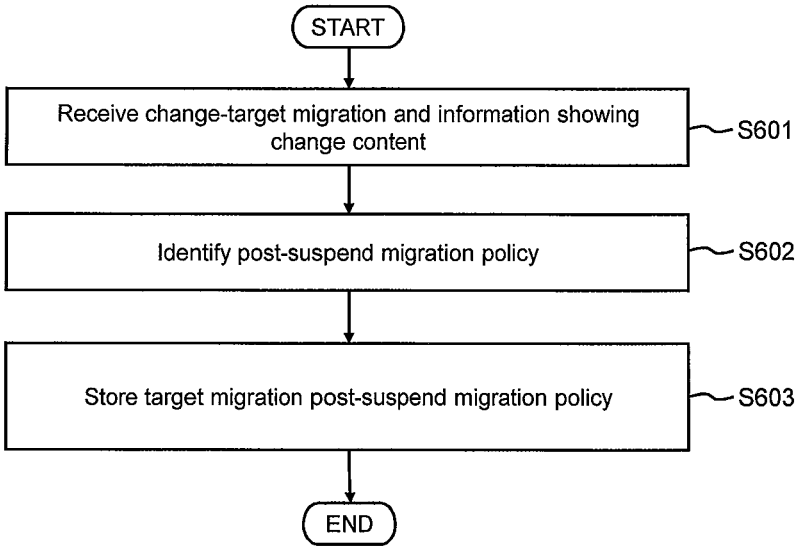

START
Receive change-target migration and information showing change content
S601
Identify post-suspend migration policy
S602
Store target migration post-suspend migration policy
S603
END

Fig. 25

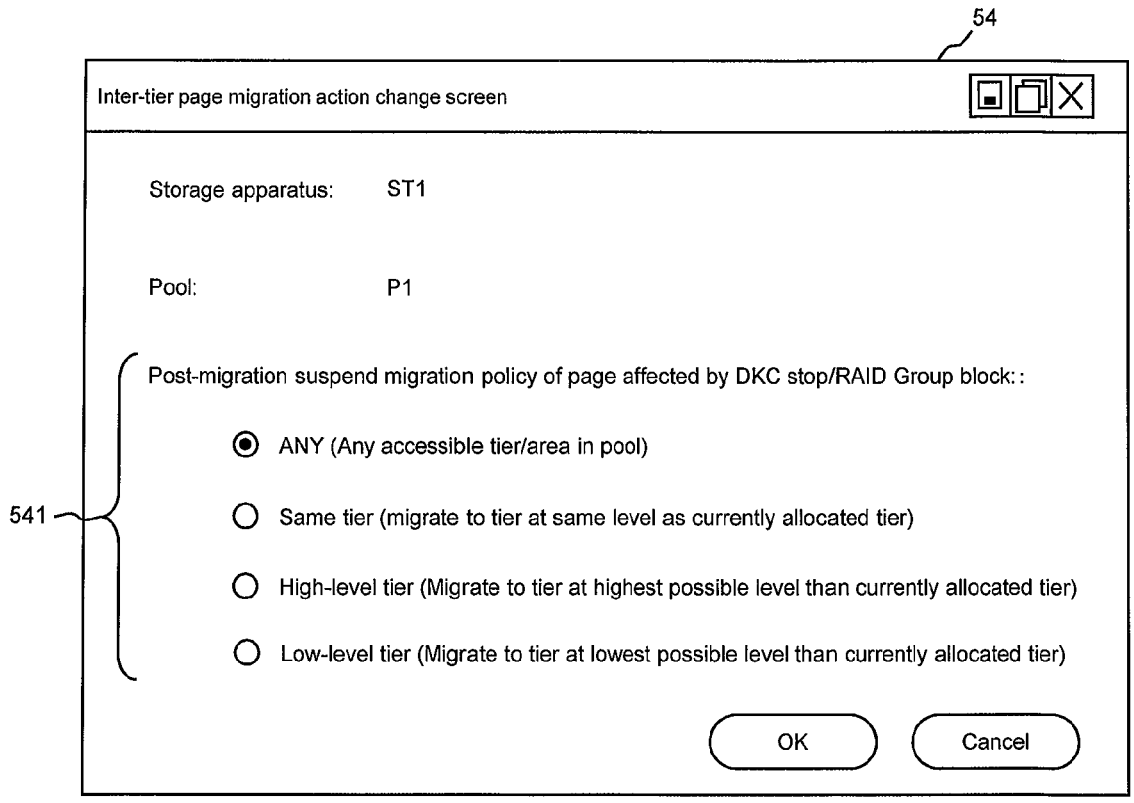

54
Inter-tier page migration action change screen
Storage apparatus: ST1
Pool: P1
Post-migration suspend migration policy of page affected by DKC stop/RAID Group block: :
541
ANY (Any accessible tier/area in pool)
Same tier (migrate to tier at same level as currently allocated tier)
High-level tier (Migrate to tier at highest possible level than currently allocated tier)
Low-level tier (Migrate to tier at lowest possible level than currently allocated tier)
OK
Cancel

Fig. 26

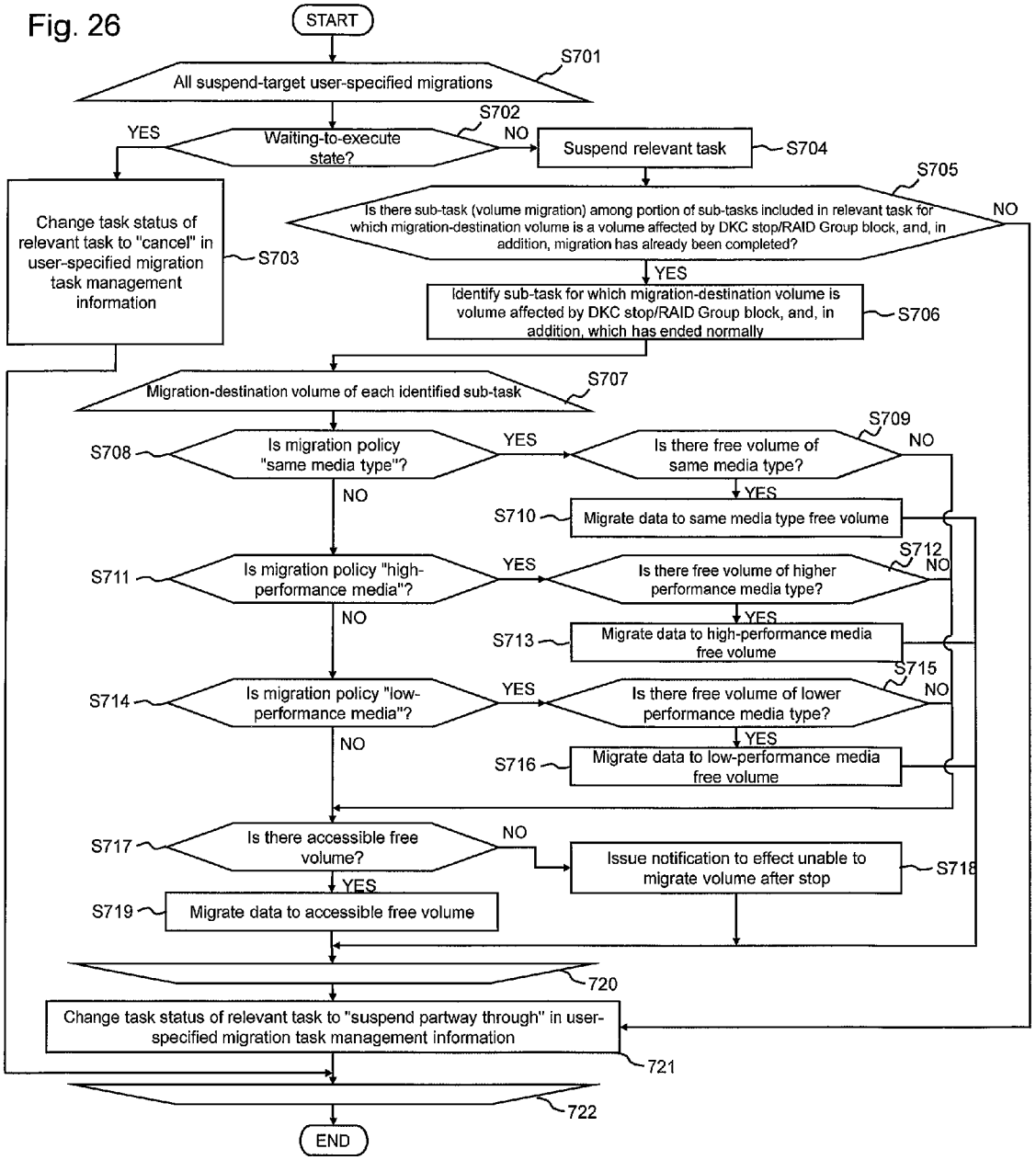

START
All suspend-target user-specified migrations
S701
Waiting-to-execute state?
S702
YES
NO
Suspend relevant task
S704
Change task status of relevant task to "cancel" in user-specified migration task management information
S703
Is there sub-task (volume migration) among portion of sub-tasks included in relevant task for which migration-destination volume is a volume affected by DKC stop/RAID Group block, and, in addition, migration has already been completed?
S705
NO
YES
Identify sub-task for which migration-destination volume is volume affected by DKC stop/RAID Group block, and, in addition, which has ended normally
S706
Migration-destination volume of each identified sub-task
S707
S708
Is migration policy "same media type"?
YES
NO
Is there free volume of same media type?
S709
NO
YES
S710
Migrate data to same media type free volume
S711
Is migration policy "high-performance media"?
YES
NO
Is there free volume of higher performance media type?
S712
NO
YES
S713
Migrate data to high-performance media free volume
S714
Is migration policy "low-performance media"?
YES
NO
Is there free volume of lower performance media type?
S715
NO
YES
S716
Migrate data to low-performance media free volume
S717
Is there accessible free volume?
NO
YES
Issue notification to effect unable to migrate volume after stop
S718
S719
Migrate data to accessible free volume
720
Change task status of relevant task to "suspend partway through" in user-specified migration task management information
721
722
END

Fig. 27

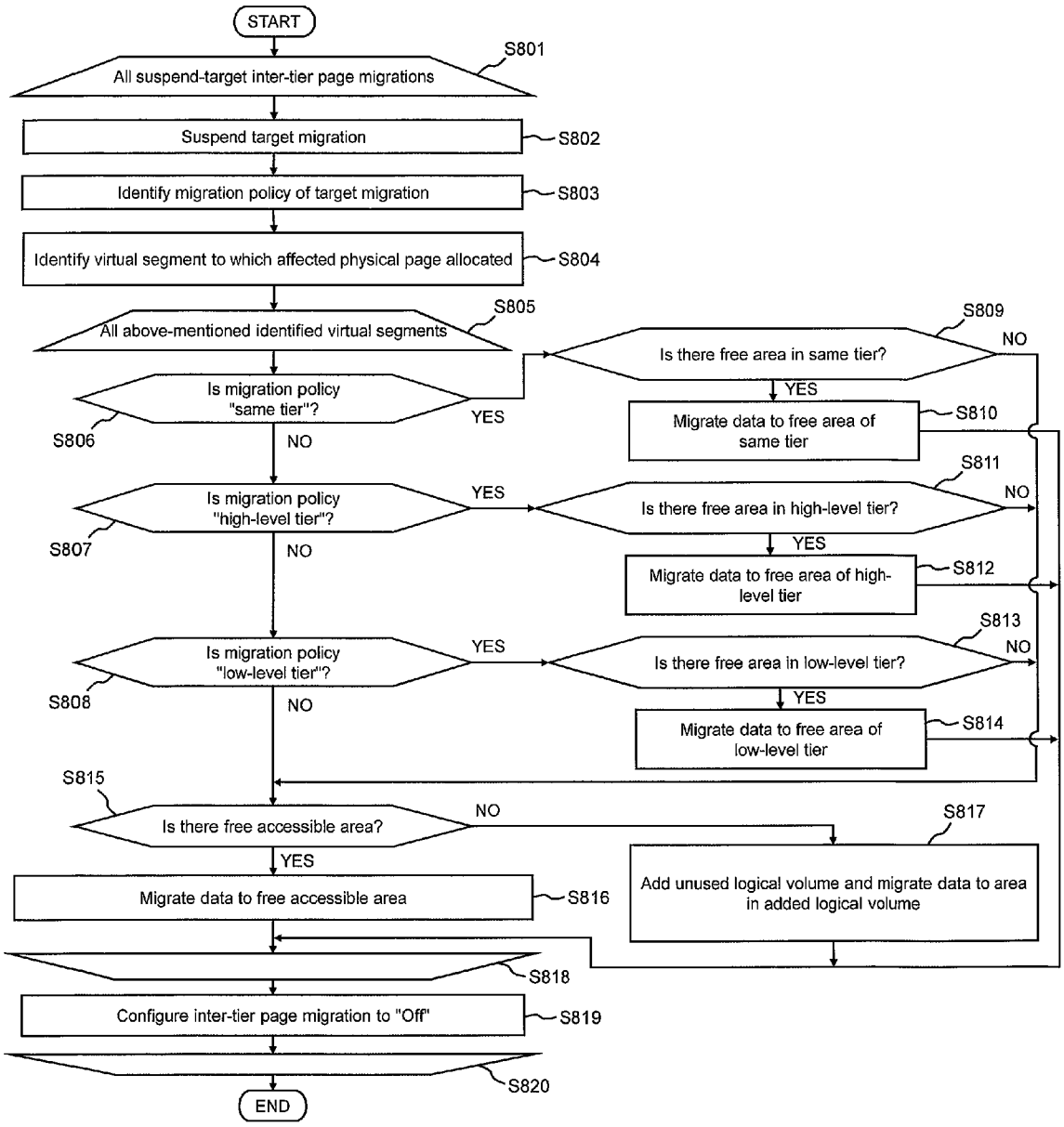

START
All suspend-target inter-tier page migrations
S801
Suspend target migration
S802
Identify migration policy of target migration
S803
Identify virtual segment to which affected physical page allocated
S804
All above-mentioned identified virtual segments
S805
Is migration policy "same tier"?
S806
YES
NO
Is migration policy "high-level tier"?
S807
YES
NO
Is migration policy "low-level tier"?
S808
YES
NO
Is there free area in same tier?
S809
NO
YES
Migrate data to free area of same tier
S810
Is there free area in high-level tier?
S811
NO
YES
Migrate data to free area of high-level tier
S812
Is there free area in low-level tier?
S813
NO
YES
Migrate data to free area of low-level tier
S814
Is there free accessible area?
S815
NO
YES
Migrate data to free accessible area
S816
Add unused logical volume and migrate data to area in added logical volume
S817
S818
Configure inter-tier page migration to "Off"
S819
S820
END

Fig. 28

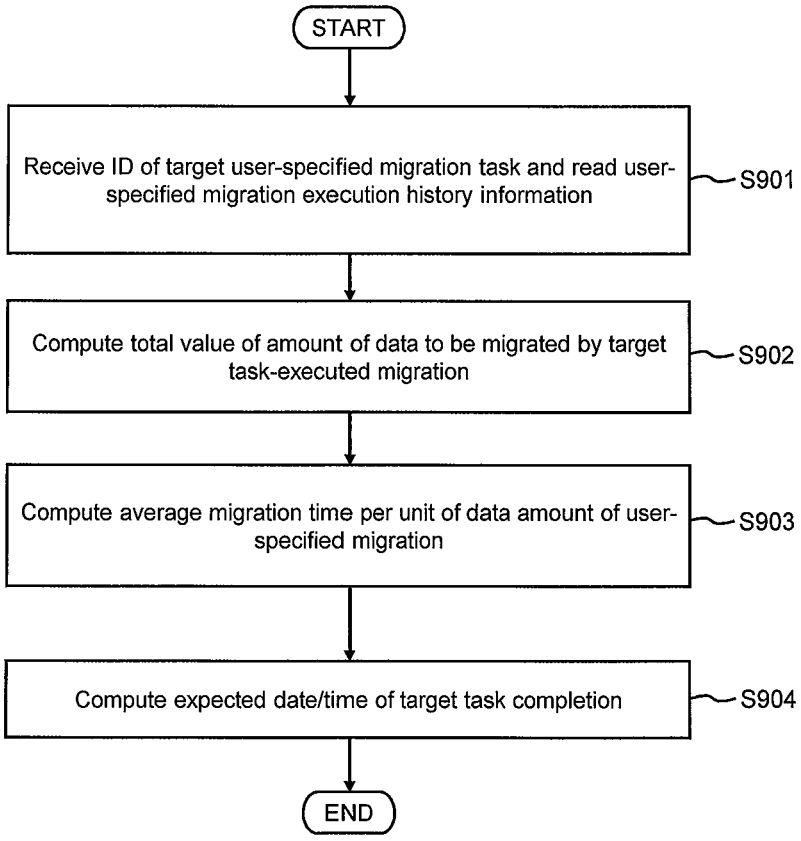

START
Receive ID of target user-specified migration task and read user-specified migration execution history information
S901
Compute total value of amount of data to be migrated by target task-executed migration
S902
Compute average migration time per unit of data amount of user-specified migration
S903
Compute expected date/time of target task completion
S904
END

Fig. 29

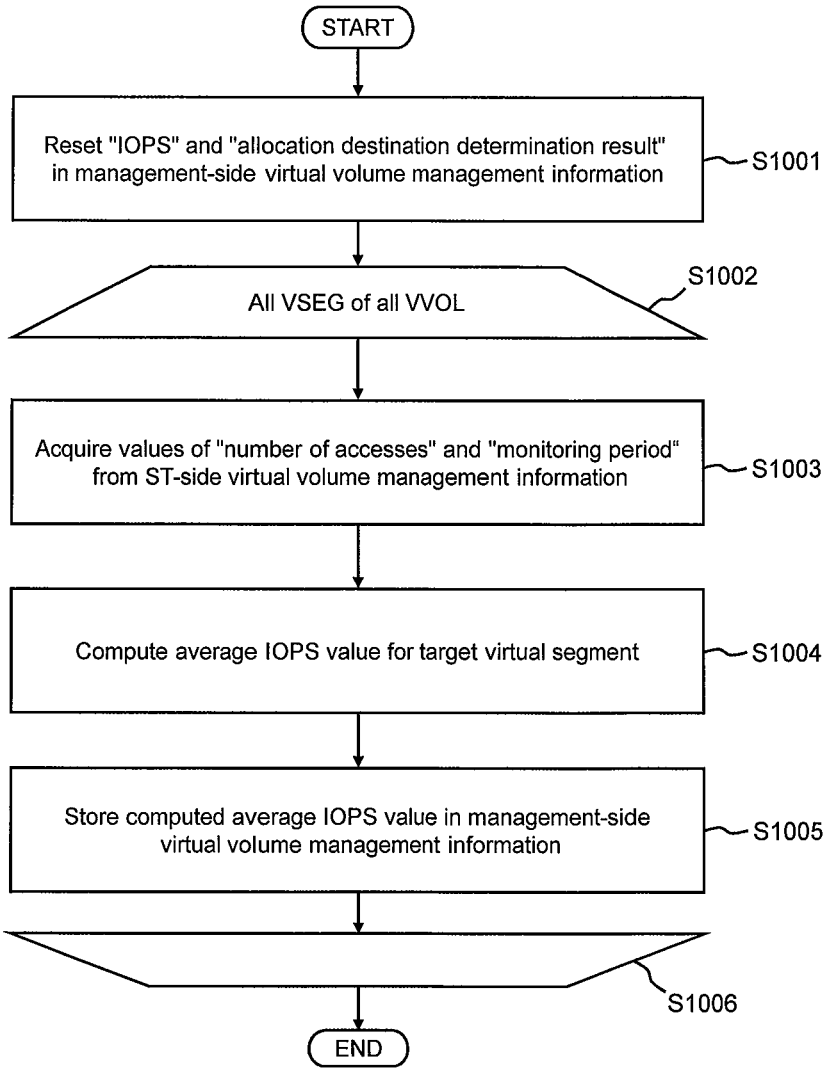

START
Reset "IOPS" and "allocation destination determination result" in management-side virtual volume management information
S1001
All VSEG of all VVOL
S1002
Acquire values of "number of accesses" and "monitoring period" from ST-side virtual volume management information
S1003
Compute average IOPS value for target virtual segment
S1004
Store computed average IOPS value in management-side virtual volume management information
S1005
S1006
END

Fig. 30

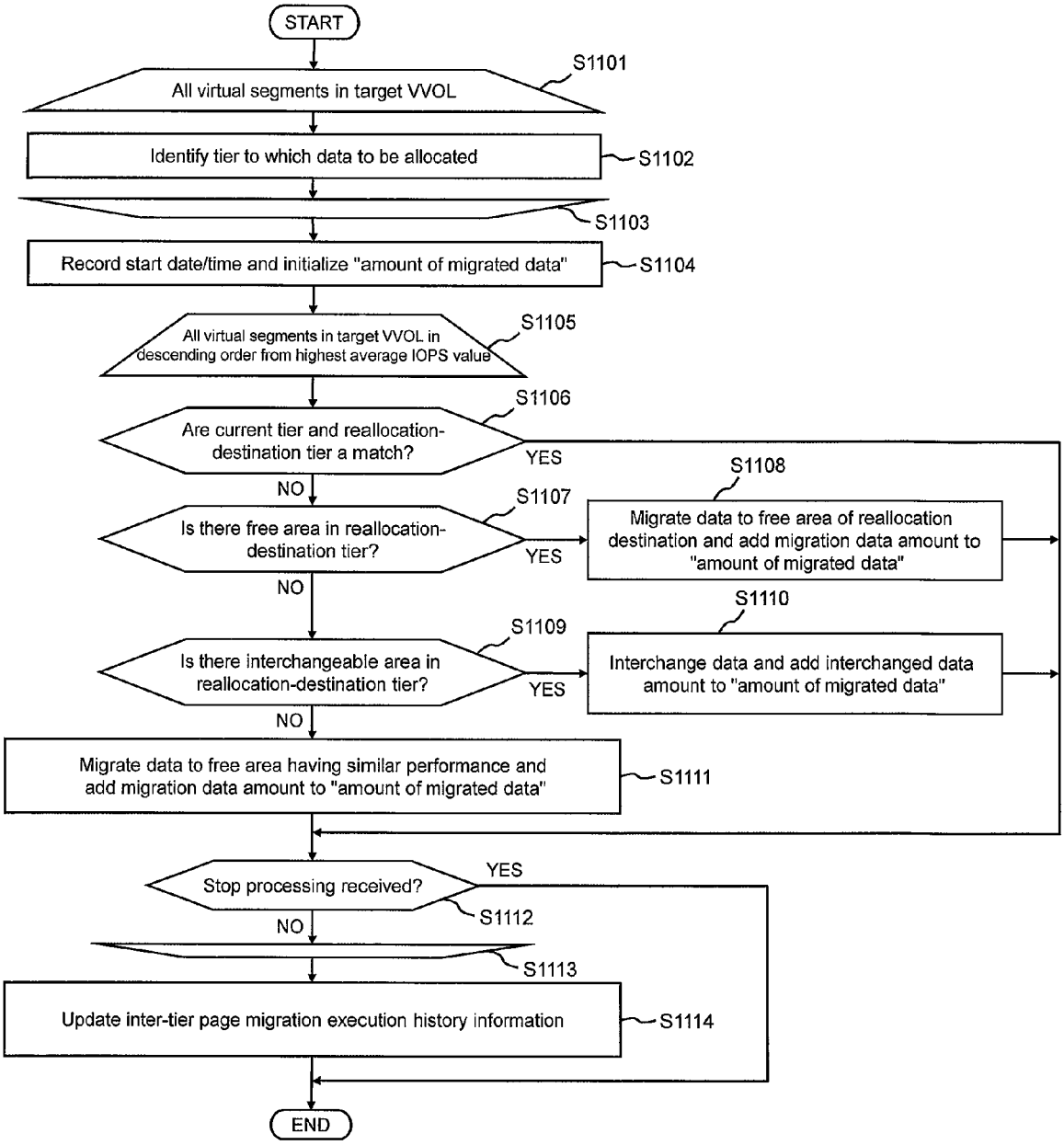

START
All virtual segments in target VVOL
S1101
Identify tier to which data to be allocated
S1102
S1103
Record start date/time and initialize "amount of migrated data"
S1104
All virtual segments in target VVOL in descending order from highest average IOPS value
S1105
Are current tier and reallocation-destination tier a match?
S1106
YES
NO
Is there free area in reallocation-destination tier?
S1107
YES
S1108
Migrate data to free area of reallocation destination and add migration data amount to "amount of migrated data"
NO
Is there interchangeable area in reallocation-destination tier?
S1109
YES
S1110
Interchange data and add interchanged data amount to "amount of migrated data"
NO
Migrate data to free area having similar performance and add migration data amount to "amount of migrated data"
S1111
Stop processing received?
YES
S1112
NO
S1113
Update inter-tier page migration execution history information
S1114
END

Fig. 31

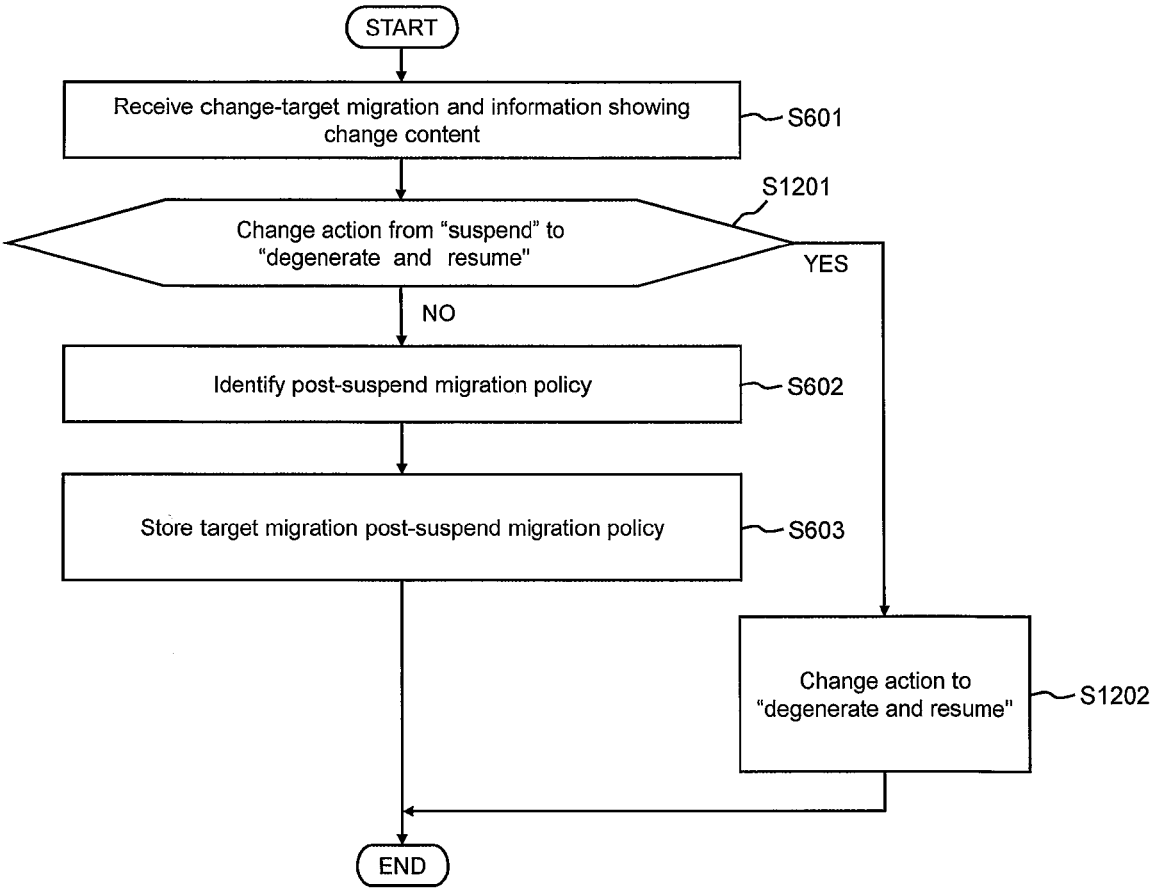

START
Receive change-target migration and information showing change content
S601
S1201
Change action from "suspend" to "degenerate and resume"
YES
NO
Identify post-suspend migration policy
S602
Store target migration post-suspend migration policy
S603
Change action to "degenerate and resume"
S1202
END

Fig. 32

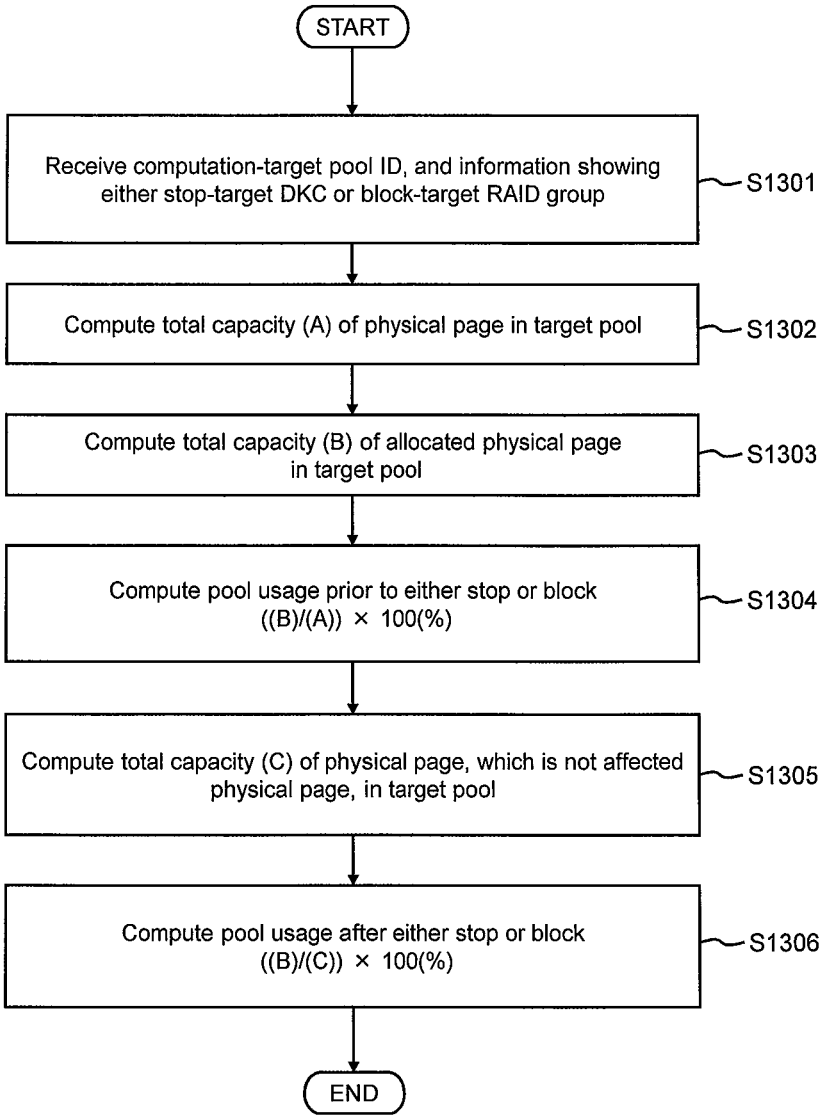
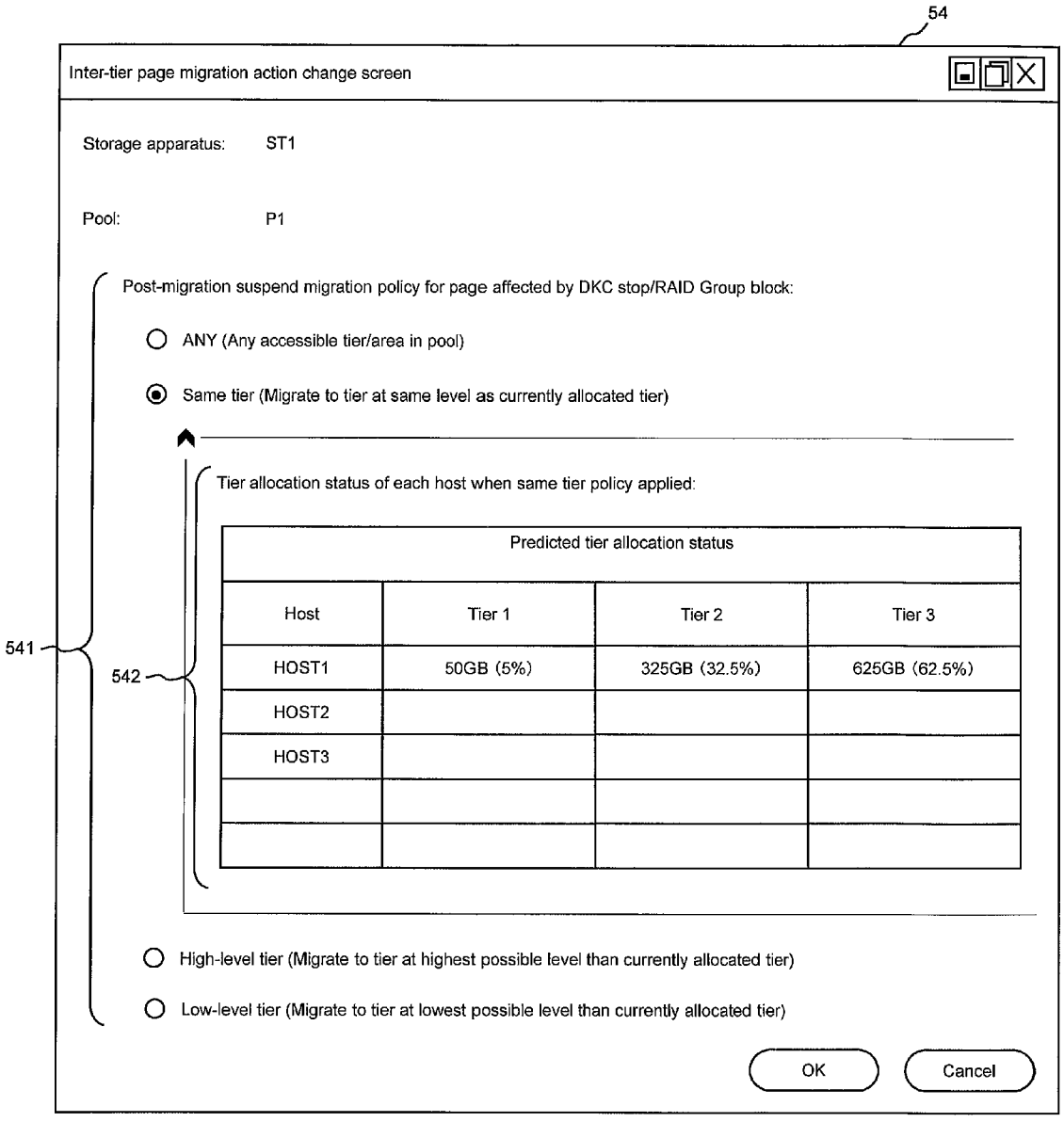

START
Receive computation-target pool ID, and information showing either stop-target DKC or block-target RAID group
S1301
Compute total capacity (A) of physical page in target pool
S1302
Compute total capacity (B) of allocated physical page in target pool
S1303
Compute pool usage prior to either stop or block ((B)/(A)) × 100(%)
S1304
Compute total capacity (C) of physical page, which is not affected physical page, in target pool
S1305
Compute pool usage after either stop or block ((B)/(C)) × 100(%)
S1306
END

Fig. 33


54
Inter-tier page migration action change screen
Storage apparatus: ST1
Pool: P1
Post-migration suspend migration policy for page affected by DKC stop/RAID Group block:
ANY (Any accessible tier/area in pool)
Same tier (Migrate to tier at same level as currently allocated tier)
Tier allocation status of each host when same tier policy applied:
Predicted tier allocation status
Host
Tier 1
Tier 2
Tier 3
HOST1
50GB (5%)
325GB (32.5%)
625GB (62.5%)
HOST2
HOST3
High-level tier (Migrate to tier at highest possible level than currently allocated tier)
Low-level tier (Migrate to tier at lowest possible level than currently allocated tier)
OK
Cancel
541
542

MANAGEMENT SYSTEM AND MANAGEMENT METHOD

TECHNICAL FIELD

The present invention relates to a management system for managing a computer system comprising a storage apparatus, and a management method therefor.

BACKGROUND ART

As a technology related to a storage apparatus, an external storage connection technology for connecting an external storage apparatus to an internal storage apparatus, which receives a request from a host, and for providing a logical volume, which exists in the external storage apparatus, to the host via the internal storage apparatus is known (refer to Patent Literature 1). In the external storage connection technology, when an I/O (Input/Output) request with respect to a logical volume has been received from the host, the internal storage apparatus determines whether the access-target logical volume is a logical volume, which exists in the internal storage apparatus, or a logical volume, which exists in the external storage apparatus, and based on the result of the determination, assigns the I/O request to the storage apparatus in which the access-target logical volume exists.

Furthermore, as a technology related to a storage apparatus, a volume migration technology for migrating data in a migration-source logical volume to a migration-destination logical volume in a state in which an I/O request from a host application can be processed as-is known (refer to Patent Literature 1). In the volume migration technology, the data of the migration-source logical volume is copied to the migration-destination logical volume, and configuration control information is configured for the migration-destination logical volume. The migration-source logical volume and the migration-destination logical volume may be logical volumes in the same storage apparatus, or may be logical volumes in different storage apparatuses.

As another technology related to a storage apparatus, a storage virtualization technology for forming a hierarchical pool using multiple types of storage devices each having a different performance, and for allocating a real storage area (hereinafter referred to as either "physical page" or "page") registered in the hierarchical pool to a virtual volume in accordance with a write access from a host is known (refer to Patent Literature 2). In the storage virtualization technology, a virtual storage area in a virtual volume is partitioned into multiple partial areas (hereinafter referred to as "virtual segment"), and a determination is made as to the tier of the hierarchical pool from which a page is to be allocated for each virtual segment. The storage apparatus, for example, either regularly or irregularly revises the tier to which a page for allocation to a virtual segment belongs (page reallocation) based on the number of I/Os with respect to the virtual segment. For example, a page belonging to a high-performance tier formed using a high-performance storage device is allocated to a virtual segment having a large number of I/Os, and a page belonging to a low-performance tier formed using a low-performance storage device is allocated to a virtual segment having a small number of I/Os.

In addition, a technology, which combines the external storage connection technology and the storage virtualization technology, creates a virtual volume in a storage apparatus in which the external storage connection technology is being applied by using multiple types of storage devices each having a different performance to form a hierarchical pool, and

revising the tier to which a page for allocation to the virtual segment belongs based on the number of I/Os to the virtual segment is known. In addition to a physical page of a storage device of an internal storage apparatus, a physical page of a storage device of an external storage apparatus can also be registered in a hierarchical pool of a storage apparatus in which the external storage connection technology is being applied.

CITATION LIST

Patent Literature

PTL 1

US Patent Application Publication No. 2008/0177947

PTL 2

US Patent Application Publication No. 2007/0055713

SUMMARY OF INVENTION

Technical Problem

In a storage apparatus in which the external storage connection technology and the storage virtualization technology are being applied, it may be desirable to stop an external storage apparatus in a state in which an I/O request from a host application is able to be processed as-is for the purpose of performing maintenance on a new version of firmware or the like. Before stopping the external storage apparatus at this time, it is necessary to suspend regular page reallocation processing performed in the hierarchical pool (hereinafter referred to simply as "reallocation process" or "inter-tier page migration"). As a process for suspending an inter-tier page migration, for example, a process in which a storage apparatus-provided Stop Migration command is executed is known.

However, in the process for suspending an inter-tier page migration on the basis of the Stop Migration command, there are cases in which the physical page in the stop-target storage device is allocated as-is to the virtual segment to be accessed by the host at the point in time when the inter-tier page migration is suspended. For this reason, after suspending the inter-tier page migration, the administrator must identify the virtual segment to which the segment in the stop-target storage device is allocated as-is from among the virtual segments accessed from the host, and change the physical page allocated to the identified virtual segment to a physical page in the storage device, which is not a stop target. This work takes a lot of time, and puts a burden on the administrator.

As a separate case, in a storage apparatus to which the external storage connection technology and the storage virtualization technology are applied, there are cases where a physical malfunction or other such failure occurs in either hardware for controlling a portion of a storage device comprising a hierarchical pool (for example, a physical drive, disk processor or the like), or hardware for controlling access to a storage device (for example, a port controller). In a portion of the high-end storage apparatuses being used in a corporate enterprise system for which business continuity is a high requirement, the hardware in the storage apparatus may be duplexed. In accordance with this, even when a failure occurs in one piece of hardware, processing can be continued using the other piece of hardware. That is, even in a state in which a failure has occurred in a single piece of hardware, an I/O

request from the host can continue to be processed, and, in addition, an inter-tier page migration in the hierarchical pool can be allowed to continue.

However, in the unlikely event that a failure occurs in the other same piece of hardware while a failure is occurring in the one piece of hardware, there is the danger that an I/O request from the host will not be able to continue to be processed. Thus, it is preferable to avoid using a storage area of a storage device controlled by hardware in which a failure has occurred until the storage apparatus recovers from the failure. Making it impossible for a storage area to be used by the host is called blocking the storage area.

Similar to a case in which the external storage apparatus is to be stopped, it is necessary to suspend an inter-tier page migration prior to blocking a storage area, but in the process for suspending the inter-tier page migration on the basis of the Stop Migration command, there are cases where the block-target storage area is allocated as-is to the virtual segment to be accessed by the host at the point in time when the inter-tier page migration has been suspended. For this reason, the administrator, after suspending the inter-tier page migration, must identify the virtual segment to which the block-target storage area has been allocated as-is from among the virtual segments to be accessed from the host, and change the physical page allocated to the identified virtual segment to a storage area, which is not a block target. This work takes a lot of time, and puts a burden on the administrator.

The above-described problems can occur in a volume-unit migration (volume migration) as well as in a page-unit migration performed in accordance with the inter-tier page migration. For example, when multiple volume migrations are implemented collectively, in a case where a volume migration, which has as the migration destination either a logical volume, which exists in a stop-target storage apparatus, or a logical volume comprising a block-target storage area, is included among the multiple volume migrations, when the collective implementation of the volume migrations is suspended part way through, data in a portion of the logical volumes may be migrated as-is to either the logical volume existing in a stop-target storage apparatus, or the logical volume comprising the block-target storage area. Thus, the administrator must identify the logical volume from which the data has been migrated to either the logical volume existing in the stop-target storage apparatus, or the logical volume comprising the block-target storage area, and migrate the data in the identified logical volume to either a logical volume, which exists in a storage apparatus not targeted for a stop, or a logical volume, which does not comprise a block-target storage area, placing a burden on the administrator.

Problems like those described above are not limited to the case of a hierarchized pool, which is configured using multiple physical pages of multiple logical volumes, and, in addition, in which physical pages are hierarchized in accordance with the performance of the segment, but rather can also occur in the case of a pool in which physical pages are not hierarchized. Specifically, in the case of a pool in which physical pages are not hierarchized, the revision of tiers allocated to virtual segments is not regularly or irregularly performed based on the number of I/Os as described above, and there are cases in which a bias occurs in the allocation of physical pages between multiple storage devices in multiple storage devices to which belong physical pages (pages), which comprise a pool and are allocated to virtual segments pursuant to an I/O request from a host application, and to solve for this bias, the storage apparatus may perform a page reallocation process (hereinafter "in-pool page migration") in the pool.

In a pool in which the physical pages are not hierarchized, similar problems can occur in a case where the storage apparatus is stopped or a storage area comprising a pool is blocked during implementation of the above-mentioned in-pool page migration.

Solution to Problem

A management system is a system for managing a computer system. The computer system comprises: multiple storage apparatuses, which, upon receiving a write request with respect to a virtual volume formed of multiple virtual segments, allocate the page to a write-destination virtual segment from a pool comprising multiple pages of multiple logical volumes and write write-target data to this page; and a host computer, which sends a data write request to a virtual volume.

The management system comprises a storage device, and a control device, which is coupled to the storage device.

The storage device stores logical volume management information and virtual volume management information. The logical volume management information is for managing a corresponding relationship between a storage apparatus in which a logical volume exists and a page comprising the logical volume with respect to a logical volume in the computer system. The virtual volume management information is for managing a corresponding relationship between a virtual segment in a virtual volume and a page allocated to the virtual segment with respect to the relevant virtual volume in the computer system.

The control device receives a selection of either a determination-target storage apparatus, which is regarded as a determination target from among multiple storage apparatuses, or a determination-target first storage area from a storage area, which comprises the page of the storage apparatus. The control device, based on the logical volume management information and the virtual volume management information, identifies from among either one or multiple page migrations, which is/are the migration of data between pages, a first page migration, which will be affected by either the determination-target storage apparatus being stopped or the first storage area being blocked, and displays information related to the first page migration.

Advantageous Effects of the Invention

The present invention makes it possible to alleviate the affects of either a storage apparatus being stopped or a storage area being blocked.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a block diagram of an example of a computer system related to an example 1.

FIG. **2** is a block diagram of an example of a host related to the example 1.

FIG. **3** is a block diagram of an example of a first storage apparatus related to the example 1.

FIG. **4** is a block diagram of an example of ST-side RAID group management information related to the example 1.

FIG. **5** is a block diagram of an example of ST-side physical page management information related to the example 1.

FIG. **6** is a block diagram of an example of ST-side logical volume management information related to the example 1.

FIG. **7** is a block diagram of an example of ST-side virtual volume management information related to the example 1.

FIG. **8** is a block diagram of an example of ST-side pool management information related to the example 1.

FIG. **9** is a block diagram of an example of a management computer related to the example 1.

FIG. **10** is a block diagram of an example of management-side RAID group management information related to the example 1.

FIG. **11** is a block diagram of an example of management-side virtual volume management information related to the example 1.

FIG. **12** is a block diagram of an example of tier management information related to the example 1.

FIG. **13** is a block diagram of an example of host management information related to the example 1.

FIG. **14** is a block diagram of an example of user-specified migration task management information related to the example 1.

FIG. **15** is a block diagram of an example of user-specified migration execution historical information related to the example 1.

FIG. **16** is a flowchart of a read process with respect to a virtual volume related to the example 1.

FIG. **17** is a flowchart of a write process with respect to a virtual volume related to the example 1.

FIG. **18** is a flowchart of a migration task management process related to the example 1.

FIG. **19** is a block diagram of an example of a user-specified migration registration screen related to the example 1.

FIG. **20** is a block diagram of an example of a migration suspend screen related to the example 1.

FIG. **21** is a flowchart of an affected migration identification process related to the example 1.

FIG. **22** is a flowchart of a user-specified migration change instruction process related to the example 1.

FIG. **23** is a block diagram of an example of a user-specified migration action change screen related to the example 1.

FIG. **24** is a flowchart of an inter-tier page migration change instruction process related to the example 1.

FIG. **25** is a block diagram of an example of an inter-tier page migration action change screen related to the example 1.

FIG. **26** is a flowchart of a user-specified migration suspend instruction process related to the example 1.

FIG. **27** is a flowchart of an inter-tier page migration suspend instruction process related to the example 1.

FIG. **28** is a flowchart of a user-specified migration required time computation process related to the example 1.

FIG. **29** is a flowchart of a performance information acquisition process related to the example 1.

FIG. **30** is a flowchart of a reallocation process related to the example 1.

FIG. **31** is a flowchart of an inter-tier page migration change instruction process related to an example 2.

FIG. **32** is a flowchart of a pool usage computation process related to an example 3.

FIG. **33** is a block diagram of an example of an inter-tier page migration action change screen related to the example 3.

DESCRIPTION OF THE EMBODIMENT

Examples will be explained by referring to the drawings. The examples explained below do not limit the invention related to the claims, and not all of the various elements and combinations thereof explained in the examples are necessarily essential as means for solving the invention. In the drawings, the same reference sign throughout multiple drawings refers to the same component.

In the following explanation, a table is used as one example of information, but information may also be expressed using a data structure other than a table.

When explaining the content of the respective information, expressions such as "identification information", "identifier", "name", and "ID" are used, but these terms are interchangeable.

In the following explanation, there may be cases where an explanation is given using a "program" as the doer of the action, but since the stipulated processing is performed in accordance with a program being executed by a processor while using a memory and a communication port (a SAN port, or a LAN port), the explanation may also give the processor as the doer of the action. A process, which is disclosed as having the program as the doer of the action, may be regarded as a process performed by a computer (a management computer, a storage apparatus, or a host). Furthermore, either all or a portion of a program may be realized in accordance with dedicated hardware. Various types of programs may be installed in respective computers using a program distribution server or computer readable storage media.

Hereinbelow, a set of one or more computers, which manage the computer system and display information for display, will be called a management system. In a case where a management computer displays the information for display, the management computer is the management system. A combination of the management computer and a display computer is also a management system. Furthermore, similar processing to that of the management computer may be realized using multiple computers to increase the speed and enhance the reliability of management processing, and in this case the relevant multiple computers (to include a display computer in a case where a display computer performs a display) are the management system.

Example 1

FIG. **1** is a block diagram of an example of a computer system related to an example 1.

The computer system comprises a management computer **1**, multiple (three in the drawing) storage apparatuses **2** (a first storage apparatus **2**A, a second storage apparatus **2**B, and a third storage apparatus **2**C), one or more hosts **3**, a SAN (Storage Area Network) **41**, and a LAN (Local Area Network) **42**. The multiple storage apparatuses **2** and the host **3** are coupled together via the SAN **41**. The management computer **1**, the multiple storage apparatuses **2**, and the host **3** are coupled together via the LAN **42**. The SAN **41** may be a FC (Fibre Channel)-based network, or may be an iSCSI (Internet Small Computer System Interface)-based network.

The management computer **1** manages the computer system. The management computer **1** comprises a migration suspend processing part **101**, an affected migration identification part **102**, and an affected migration change/suspend instruction part **103**. The migration suspend processing part **101**, the affected migration identification part **102**, and the affected migration change/suspend instruction part **103** are functional parts built in accordance with a CPU **11**, which will be explained further below, executing a migration suspend program **123**.

The host **3** is a computer (a server), which executes a server program and so forth, and provides a prescribed service. The host **3** comprises an application program **321**. The host **3** application program **321** accesses either a virtual volume (VVOL) **266** or a logical volume (LVOL) **264** (**264**A, **264**B, **264**C, and so forth) provided by the storage apparatus **2**.

The storage apparatus **2** provides a storage area to the host **3**. The storage apparatus **2** comprises a controller **20** for controlling the storage apparatus **2**, and multiple storage devices **261** (storage devices **261**A, **261**D, **261**E, and so forth) for storing and reading data. The storage apparatus **2** provides the host **3** with a storage area in the form of a logical volume **264** (logical volume **264**A, logical volume **264**B, and so forth). The logical volume **264** is created from an unused storage area of the storage device **261**. The host **3** uses the storage area via the logical volume **264**.

In this example, a first storage apparatus **2**A is an internal storage apparatus, a second storage apparatus **2**B and a third storage apparatus **2**C are external storage apparatuses, which are externally coupled to the first storage apparatus **2**A. The first storage apparatus **2**A comprises a logical volume **264**A (LVOL **1**), the second storage apparatus **2**B comprises a logical volume **264**B (LVOL **2**), and the third storage apparatus **2**C comprises a logical volume **264**C (LVOL **3**). In this example, the external storage apparatuses do not comprise controllers **20**, and the logical volumes **264**B and **264**C (hereinafter referred to as "external volumes") of the external storage apparatuses are provided to the host **3** via the first storage apparatus, which is the internal storage apparatus. In the drawing, the external volumes, for example, are written as "EVOL **2**" and "EVOL **3**". The "EVOL **2**" corresponds to the "LVOL **2**", which exists in the second storage apparatus **2**B, and the "EVOL **3**" corresponds to the "LVOL **3**", which exists in the third storage apparatus **2**C.

The first storage apparatus **2**A also provides the host **3** with the virtual volume **266**. Only the volume size and access method of the virtual volume **266** are defined; it does not comprise a physical page **271** (physical page **271**A, physical page **271**B, physical page **271**C) for storing data. The virtual volume **266** is associated with a pool **265**. Briefly explained, in a case where data is written from the host **3** to a virtual segment (VSEG) **272** inside the virtual volume **266**, a physical page (SEG) **271** selected from the pool **265** is allocated to the virtual volume **266**. Data from the host **3** is written to the physical page **271** allocated to the virtual segment **272**. In the drawing, physical pages **271** included in the external volume, for example, are written as "ESEG-B" and "ESEG-C". The "ESEG-B" corresponds to the "SEG-B" included in "LVOL **2**", and the "ESEG-C" corresponds to the "SEG-C" included in "LVOL **3**".

In this example, the pool **265** is a hierarchical pool, and comprises multiple storage tiers **2651** (a first tier **2651**A, a second tier **2651**B, and a third tier **2651**C) having different performance. The first tier **2651**A (tier **1**) is configured from multiple physical pages **271**A of the highest performance storage device **261**A. The first tier **2651**A can also be called the high-level tier. The second tier **2651**B (tier **2**) is configured from multiple physical pages **271**B of a medium-performance storage device **261**B (not shown in the drawing). The second tier **2651**B can also be called the mid-level tier. The third tier **2651**C (tier **3**) is configured from multiple physical pages **271**C of a low-performance storage device **261**C (not shown in the drawing). The third tier **2651**C can also be called the low-level tier. Each physical page **271** belonging to the multiple storage tiers **2651** of the pool **265**, for example, becomes usable in accordance with the logical volume **264** comprising the physical pages **271** corresponding to the respective tiers **2651** being registered in the pool **265**. The pool **265** related to this example is configured from the logical volume **264**A of the internal storage apparatus (hereinafter referred to as "internal volume") and the external volumes **265**B and **264**C. In the pool **265**, an inter-tier page migration is implemented on a regular or irregular basis.

The embodiment will be explained premised on the pool of the storage apparatus being a hierarchical pool, but the method of the embodiment can be applied in the same way even in a case where the above-mentioned in-pool page migration is implemented in a pool, which is not hierarchized.

In a case where the host **3** writes data to an unallocated virtual segment **272** in the virtual volume **266**, any of the tiers **2651** in the pool **265** is selected, and a physical page **271** belonging to the selected tier **2651** is allocated to the write-target virtual segment **272**. Write data from the host **3** is written to the physical page **271**, which has been allocated to the write-target virtual segment **272**.

In the configuration of FIG. **1**, for example, in a case where the third storage apparatus **2**C, which is an external storage apparatus, is stopped for maintenance or the like, the host **3** is no longer able to access the physical page **271**C inside the third storage apparatus **2**C. Since the pool **265** of the first storage apparatus **2**A comprises the physical page **271**C, which has become inaccessible due to the stoppage of the third storage apparatus **2**C, the management computer **1** suspends (invalidates) the inter-tier page migration involving the physical page **271**C. This is because letting this inter-tier page migration remain valid as-is could result in the inaccessible physical page **271**C being automatically allocated to a virtual segment **272**. There are also cases in which the inaccessible physical page **271**C is allocated to a virtual segment **272** at the point in time when the inter-tier page migration is stopped. To deal with this, the management computer **1** changes the physical page **271** allocated to the virtual segment **272** from the inaccessible physical page **271**C to another physical page **271**, which is accessible.

The external storage apparatuses (the second storage apparatus **2**B and the third storage apparatus **2**C) need not comprise controllers **20**, or the external storage apparatuses may comprise controllers **20**. In a case where the external storage apparatuses both comprise a controller **20**, the host **3** is able to directly access both the second storage apparatus **2**B and the third storage apparatus **2**C. That is, the second storage apparatus **2**B and the third storage apparatus **2**C can also directly receive an I/O request with respect to their own storage apparatus **2** from the host **3**, and the first storage apparatus **2**A can receive an I/O request with respect to its own storage apparatus **2** via either the second storage apparatus **2**B or the third storage apparatus **2**C. In accordance with this, the processing explained hereinbelow can be performed the same way in a case where any of the first storage apparatus **2**A, the second storage apparatus **2**B, or the third storage apparatus **2**C is stopped.

FIG. **2** is a block diagram of an example of a host related to the example 1.

The host **3** comprises a CPU (Central Processing Unit) **31**, a memory **32**, a SAN port **33**, a LAN port **34**, and an internal bus **35**. The CPU **31**, the memory **32**, the SAN port **33**, and the LAN port **34** are coupled to one another via the internal bus **35**. The SAN port **33** is an interface device for coupling to the SAN **41**. The LAN port **34** is the interface device for coupling to the LAN **42**.

The memory **32** stores an application program **321**, a host configuration information sending program **322**, and host configuration information **323**. The host configuration information **323** is for managing a corresponding relationship between the host **3**, and the virtual volume **266** and the logical volume **264**, which the host **3** accesses. For example, the host configuration information **323** stores an identifier of either the logical volume **264** or the virtual volume **266**, which is allocated to the host **3**, that is, which the host accesses, and the identifier of the storage apparatus **2** in which the allocated

either logical volume **264** or virtual volume **266** exists. The host configuration information sending program **322** is for sending the host configuration information **323** to the management computer **1** based on a request by the management computer **1**.

FIG. **3** is a block diagram of an example of a first storage apparatus related to the example 1.

The first storage apparatus **2**A comprises a controller **20**, multiple physical storage devices **261** with different performance (storage device **261**A, storage device **261**D, and storage device **261**E in the drawing), and an internal bus **28**. The controller **20** and the storage devices **261** are coupled to one another via the internal bus **28**.

For example, various types of devices capable of reading and writing data can be used as the storage device **261**, such as a hard disk device, a semiconductor memory device, an optical disk device, a magneto-optical disk device, a magnetic tape device, and a flexible disk device. In a case where a hard disk device is used as the storage device **261**, for example, a FC (Fibre Channel) disk, a SCSI (Small Computer System Interface) disk, a SATA (serial ATA) disk, an ATA (AT Attachment) disk, and a SAS (Serial Attached SCSI) disk may be used. For example, a flash memory, a FeRAM (Ferroelectric Random Access Memory), a MRAM (Magnetoresistive Random Access Memory), a phase-change memory (Ovonic Unified Memory), a RRAM (registered trademark) (Resistance RAM) or other such storage device may also be used. In addition, for example, the configuration may be such that different types of storage devices **261**, like a flash memory device and a hard disk device, are intermixed. In this example, the storage device **261**A is a relatively high-performance SSD (flash memory device), the storage device **261**D is a medium-performance SAS disk, and the storage device **261**E is a relatively low-performance SATA disk.

A RAID group **262** (RAID group **262**A, RAID group **262**D, and RAID group **262**E) is created by grouping together storage devices **261** of the same type. The RAID group **262**A is configured from physical storage areas of multiple high-performance storage devices **261**A. The RAID group **262**D is configured from physical storage areas of multiple medium-performance storage devices **261**D. The RAID group **262**E is configured from physical storage areas of multiple low-performance storage devices **261**E.

An LU **263** corresponding to a logical volume **264** (LU **263**A, LU **263**D, and LU **263**E) can be provided by segmenting the physical storage areas of the respective RAID groups **262** into either fixed sizes or variable sizes. The LU **263**A is disposed on the high-performance RAID group **262**A. The LU **263**D is disposed on the medium-performance RAID group **262**D. The LU **263**E is disposed on the low-performance RAID group **262**E. Therefore, the LU **263**A is a high-performance logical storage device, the LU **263**D is a medium-performance logical storage device, and the LU **263**E is a low-performance logical storage device. The LU **263**A corresponds to the logical volume **264**A (refer to FIG. **1**), and LUs **263**D and **263**E each correspond to a different logical volume than the logical volume **264**A. The fact that the LU corresponds to the logical volume here denotes that the LU and the logical volume share the same physical storage area inside the storage apparatus. In this example, the LU and the logical volume are regarded as separate components, but the LU and the logical volume may be expressed as the same component (that is, the LU and the logical volume may be regarded as identical).

The controller **20** comprises a CPU **21**, a memory **22**, one or more SAN ports **23**, a LAN port **24**, and a disk I/F (interface) **25**. The SAN port **23** is the interface device for coupling to the SAN **41**. The LAN port **24** is the interface device for coupling to the LAN **42**.

The memory **22** stores a storage control program **221**, ST-side RAID group management information **222**, ST-side physical page management information **223**, ST-side logical volume management information **224**, ST-side virtual volume management information **225**, and ST-side pool management information **226**. The ST-side RAID group management information **222**, the ST-side physical page management information **223**, the ST-side logical volume management information **224**, the ST-side virtual volume management information **225**, and the ST-side pool management information **226** will be explained further below. In the explanation of the embodiment, "ST" is the abbreviation for storage apparatus.

The storage control program **221** comprises a performance monitoring program **2211**, a virtual volume (VVOL) management program **2212**, and a data migration program **2213** as sub-programs. The storage control program **221**, in accordance with being executed by the CPU **21**, performs processing for controlling access to the storage device **261**, processing for monitoring performance, and processing for managing the virtual volume.

The performance monitoring program **2211** collects performance with respect to the virtual volume **266**. The performance monitoring program **2211** tabulates the access frequencies for the respective virtual volumes **266** in the storage apparatus **2**, and records these access frequencies in the ST-side virtual volume management information **225**. The access frequency for the virtual volume **266**, for example, is a set of the number of times the host **3** has accessed the respective virtual segments **272** in the virtual volume **266**, and is tabulated for each virtual segment **272**.

The number of accesses to a virtual segment **272** refers to the number of access requests for which processing has been completed (or may also include processing, which is currently in progress) from among the access requests, which specify either all or a portion of the virtual segments **272** as a range of addresses. For example, in a case where the address range of an access request is either all or a portion of a certain virtual segment **272** (in other words, the virtual segment **272** comprises the range of addresses of the access request), the performance monitoring program **2211** increases the number of accesses of the relevant virtual segment **272** in proportion to the number of relevant access requests. As another example, in a case where the address range of an access request comprises either all or a portion of each of multiple virtual segments **272**, the performance monitoring program **2211** increases the number of accesses of each of the multiple virtual segments **272** in proportion to the number of relevant access requests. The latter does not occur very often in the case of a virtual segment **272** that is large in size. Therefore, the performance monitoring program **2211** may increase the number of accesses by the count number of the virtual segment **272** comprising the head of the address range specified by the access request.

The virtual volume management program **2212** revises the allocation of a physical page **271** to a virtual segment **272** in the virtual volume **266** based on an instruction from the reallocation program **1212** of the management computer **1** (refer to FIG. **9**).

The data migration program **2213** performs a data migration (volume migration) to a migration-destination logical volume **264** (hereinafter referred to as "migration-destination volume") from a migration-source logical volume **264** (hereinafter referred to as "migration-source volume") based on an

instruction from the migration task management program **122** (refer to FIG. **9**) of the management computer **1**.

Specifically, the data migration program **2213** copies data inside the migration-source volume to the migration-destination volume, and either overwrites the configuration control information of the migration-destination volume with the configuration control information of the migration-source volume, or interchanges the configuration control information of the migration-destination volume with the configuration control information of the migration-source volume. As used here, the configuration control information of the logical volume **264**, for example, is the identifier (for example, the volume number) of the logical volume **264**. The migration-source volume and the migration-destination volume, for example, are specified by the administrator via the management computer **1**.

Next, the configurations of the second storage apparatus and the third storage apparatus will be explained.

The configurations of the second storage apparatus **2**B and the third storage apparatus **2**C are substantially the same as that of the first storage apparatus **2**A with the exception of the programs stored in the memories **22**. The second storage apparatus **2**B and the third storage apparatus **2**C related to this example do not store the storage control program **221**, the ST-side virtual volume management information **225**, and the ST-side pool management information **226**.

The second storage apparatus **2**B and the third storage apparatus **2**C, like the first storage apparatus **2**A, may store the storage control program **221**, the ST-side virtual volume management information **225**, and the ST-side pool management information **226**. In accordance with this, the host **3** is also able to directly access the second storage apparatus **2**B and the third storage apparatus **2**C. That is, the second storage apparatus **2**B and the third storage apparatus **2**C can also directly receive an I/O request with respect to their own storage apparatus **2** from the host **3**, and the first storage apparatus **2**A can receive an I/O request with respect to its own storage apparatus **2** via the second storage apparatus **2**B or the third storage apparatus **2**C. This makes it possible to lessen setting changes and other such work and to reduce the time and effort of the administrator even in a case where it becomes necessary to stop the first storage apparatus **2**A.

In this example, the second storage apparatus **2**B comprises multiple storage devices, which are examples of medium-performance SAS disks (hereinafter, medium-performance storage device), and comprises a RAID group configured from multiple medium-performance storage devices (hereinafter, medium-performance RAID group). A LU is disposed on the medium-performance RAID group as a medium-performance logical storage device (hereinafter, medium-performance LU), and the medium-performance LU corresponds to the logical volume **264**B (refer to FIG. **1**). The third storage apparatus **2**C comprises multiple storage devices, which are examples of relatively low-performance SATA disks (hereinafter, low-performance storage device), and comprises a RAID group configured from multiple low-performance storage devices (hereinafter, low-performance RAID group). A LU is disposed on the low-performance RAID group as a low-performance logical storage device (hereinafter, low-performance LU), and the low-performance LU corresponds to the logical volume **264**C (refer to FIG. **1**).

The second storage apparatus **2**B and the third storage apparatus **2**C, as external storage apparatuses with respect to the first storage apparatus **2**A, provide the host **3** with the logical volume **264**B and the logical volume **264**C via the first storage apparatus **2**A. That is, the host **3** reads/writes data from/to the logical volume **264**B or the logical volume **264**C via the first storage apparatus **2**A.

FIG. **4** is a block diagram of an example of ST-side RAID group management information related to the example 1.

The ST-side RAID group management information **222** is for the storage apparatus **2** to manage the configuration of the RAID group **262**, which exists in the relevant storage apparatus **2**. The ST-side RAID group management information **222**, for example, is configured as a table, and comprises the information items RAID group ID **2221**, device type **2222**, RAID level **2223**, and storage device ID (PDEV-ID) **2224**.

An identifier of a RAID group **262** is stored in the RAID group ID **2221**. Data showing the type of storage device **261** comprising the RAID group **262** is stored in the device type **2222**. Data showing the RAID level and combination of the RAID group **262** is stored in the RAID level **2223**. The identifiers of the storage devices **261** comprising the RAID group **262** are stored in the storage device ID **2224**.

A portion of the information items shown in the drawing may be changed to other information items, and new information items may be added; the same holds true for the respective information (tables) described hereinbelow. In addition, one table may be managed by being partitioned into multiple tables.

FIG. **5** is a block diagram of an example of ST-side physical page management information related to the example 1.

The ST-side physical page management information **223** is for the storage apparatus **2** to manage whether or not the physical pages **271** of the respective RAID groups **262**, which exist in the relevant storage apparatus **2**, have been allocated to a virtual volume **266**. The ST-side physical page management information **223**, for example, is configured as a table, and comprises the information items RAID group ID **2231**, physical page ID **2232**, RAID group LBA range **2233**, and allocation status **2234**.

The identifier of a RAID group **262** is stored in the RAID group ID **2231**. The identifier of a physical page **271** of the RAID group **262** is stored in the physical page ID **2232**. Data showing an LBA range of the RAID group **262** corresponding to the physical page **271** is stored in the RAID group LBA range **2233**. LBA is the abbreviation for logical block address. Data showing whether or not the physical page **271** has been allocated to a virtual volume **266** is stored in the allocation status **2234**. In addition to the virtual volume **266**, the logical volume **264** is also an allocation destination of the physical page **271**. The storage control program **221** exercises control so that one physical page **271** is not allocated to different virtual volumes **266**, and exercises control so that one physical page **271** is not allocated to different logical volumes **264**.

FIG. **6** is a block diagram of an example of ST-side logical volume management information related to the example 1.

The ST-side logical volume management information **224** is for the storage apparatus **2** to manage a physical page **271** included in a logical volume **264** with respect to the logical volume **264**, which exists in the relevant storage apparatus **2**, and the external volume (the logical volume **264**) of the relevant storage apparatus **2**. The ST-side logical volume management information **224**, for example, is configured as a table, and comprises the information items logical volume ID (LVOL-ID) **2241**, physical page ID **2242**, external storage apparatus ID **2243**, mapping-source logical volume ID **2244**, and mapping-source physical page ID **2245**.

The identifier of a logical volume **264** is stored in the logical volume ID **2241**. The identifier stored in the logical volume ID **2241** is not an identifier specified by the host **3**, but rather is an identifier, which is recognized internally in the

storage apparatus **2**. In a case where the logical volume **264** is an external volume, an identifier given to the internal storage apparatus side (EVOL **2**, EVOL **3**, and so forth) is stored in the logical volume ID **2241**. The identifier of a physical page **271** included in the logical volume **264** is stored in the physical page ID **2242**. In a case where the logical volume **264** is an external volume, an identifier given to the internal storage apparatus side (ESEG **1**, ESEG **2**, and so forth) is stored in the physical page ID **2242**.

The identifier of the storage apparatus **2** in which exists a logical volume **264**, which is an external volume, is stored in the external storage apparatus ID **2243**. In a case where the logical volume **264** is the internal volume, "n/a" is stored in the external storage apparatus ID **2243**. The external storage apparatus-side identifier (LVOL **2**, LVOL **3**, and so forth) of a logical volume **264**, which is an external volume, is stored in the mapping-source logical volume ID **2244**. The external storage apparatus-side identifier (SEG **1**, SEG **2**, and so forth) of a physical page **271** included in the logical volume **264**, which is an external volume, is stored in the mapping-source physical page ID **2245**.

FIG. **7** is a block diagram of an example of ST-side virtual volume management information related to the example 1.

The ST-side virtual volume management information **225** is for the storage apparatus **2** to manage information related to a virtual segment **272** and a physical page **271** allocated to this virtual segment **272** with respect to a virtual volume **266** provided by the relevant storage apparatus **2**. The ST-side virtual volume management information **225**, for example, is configured as a table, and comprises the information items virtual volume ID (VVOL-ID) **2251**, virtual segment ID **2252**, virtual volume LBA range (VVOL LBA range) **2253**, physical page ID **2254**, number of accesses **2255**, monitoring period **2256**, and reallocation destination determination result **2257**.

The identifier of a virtual volume **266** is stored in the virtual volume ID **2251**. The identifier stored in the virtual volume ID **2251** is not an identifier specified by the host **3**, but rather is an identifier recognized internally in the storage apparatus **2**. The identifier of a virtual segment **272** included in the virtual volume **266** is stored in the virtual segment ID **2252**. Data showing the LBA range corresponding to the virtual segment **272** in the virtual volume **266** is stored in the virtual volume LBA range **2253**. The identifier of the physical page **271** allocated to the virtual segment **272** in the virtual volume **266** is stored in the physical page ID **2254**.

A value showing the number of accesses from the host **3** (cumulative number of I/Os) with respect to the virtual segment **272** in the virtual volume **266** is stored in the number of accesses **2255**. Monitoring of the number of accesses by the storage apparatus **2** is performed within a time range configured in the monitoring period **2256**. In a case where a value showing a specified period of time is not configured in the monitoring period **2256**, the storage apparatus **2**, for example, constantly monitors the number of accesses. The storage apparatus **2** resets the value of the number of accesses **2255** to 0 at the time at which monitoring starts. In a case where the monitoring result is not stored during the monitoring period, the value of the number of accesses **2255** is reset to 0 at fixed time periods, for example, every 24 hours.

Data showing the monitoring period by the performance monitoring program **2211**, that is, the time range during which the performance monitoring program **2211** monitors the number of accesses with respect to the virtual volume **266** and stores the monitoring result, is stored in the monitoring period **2256**. The monitoring period value may be given beforehand as a fixed value, or may be an arbitrary value configured via the management computer **1**. Data showing a data reallocation-destination tier **2651** determined in accordance with a reallocation process, which will be explained further below (refer to FIG. **30**), is stored in the reallocation destination determination result **2257**. A tier **2651**, which supplies the physical page **271** allocated to the virtual segment **272** in the virtual volume **266**, is decided in the reallocation process.

FIG. **8** is a block diagram of an example of ST-side pool management information related to the example 1.

The ST-side pool management information **226** is for the storage apparatus **2** to manage the configuration of the pool **265**, which exists inside the relevant storage apparatus **2**, and setting contents related to an inter-tier page migration performed in this pool **265**. The ST-side pool management information **226**, for example, is configures as a table, and comprises the information items pool ID (Pool-ID) **2261**, pool configuration logical volume ID (Pool configuration LVOL-ID) **2262**, storage apparatus **2263**, inter-tier page migration **2264**, migration cycle **2265**, and monitoring time period **2266**.

The identifier of a pool **265** is stored in the pool ID **2261**. The identifier of a logical volume **264** comprising the pool **265** is stored in the pool configuration logical volume ID **2262**. The identifier of the storage apparatus **2** in which the logical volume **264** comprising the pool **265** exists is stored in the storage apparatus **2263**. Data showing whether or not an inter-tier page migration is to be performed, that is, whether an inter-tier page migration is valid or invalid, is stored in the inter-tier page migration **2264**. For example, in a case where an inter-tier page migration is valid, "ON" is stored in the inter-tier page migration **2264**, and in a case where an inter-tier page migration is invalid, "OFF" is stored in the inter-tier page migration **2264**. Data showing a cycle for performing inter-tier page migrations is stored in the migration cycle **2265**. Data showing a performance monitoring time period for acquiring an access frequency referenced by the reallocation process is stored in the monitoring time period **2266**.

FIG. **9** is a block diagram of an example of a management computer related to the example 1.

The management computer **1** comprises a CPU **11**, a memory **12**, an auxiliary storage device **13**, a LAN port **14**, and an internal bus **15**. The CPU **11**, the memory **12**, the auxiliary storage device **13**, and the LAN port **14** are coupled to one another via the internal bus **15**. The LAN port **14** is the interface device for coupling to the LAN **42**.

The memory **12** stores a configuration management program **121**, a migration task management program **122**, a migration suspend program **123**, tier management information **124**, management-side RAID group management information **125**, management-side physical page management information **126**, management-side logical volume management information **127**, management-side virtual volume management information **128**, management-side pool management information **129**, and host management information **120**. The auxiliary storage device **13** stores user-specified migration task management information **131**, user-specified migration execution history information **132**, and inter-tier page migration execution history information **133**. The various types of information **124** through **129**, **120**, and **131** through **133** will be explained further below.

The configuration management program **121** comprises a performance information acquisition program **1211** and a reallocation program **1212** as sub-programs. The performance information acquisition program **1211** acquires the number of accesses with respect to each virtual segment **272** from the storage apparatus **2**, computes an average value

(hereinafter, "average IOPS value") of the number of accesses per unit of time (in this example, IOPS (number of I/Os per second)), and stores this average IOPS value in the management-side virtual volume management information **128**. The reallocation program **1212** is the program, which performs the reallocation process. The reallocation program **1212** decides the tier **2651** to which virtual segment **272** data is to be allocated based on the average IOPS value for each virtual segment **272**.

The migration task management program **122** instructs the start of execution for a volume migration specified by the user (hereinafter, referred to as "user-specified migration") at a specified date and time based on the contents of the user-specified migration task management information **131**.

The migration suspend program **123** (hereinafter written as "suspend program **123**") comprises an affected migration identification program **1231**, a user-specified migration change instruction program **1232**, an inter-tier page migration change instruction program **1233**, a migration suspend instruction program **1234**, a user-specified migration required time computation program **1235**, and an inter-tier page migration required time computation program **1236**. The suspend program **123**, based on input information specifying either a stop-target storage apparatus **2** or a block-target storage area (either a determination-target storage apparatus, which is regarded as a determination target, or a first storage area), identifies a user-specified migration and an inter-tier page migration, which will be affected by either a storage apparatus **2** being stopped or a storage area being blocked, and, for example, based on an instruction from the administrator, performs setting changes for the identified user-specified migration and inter-tier page migration, and suspends the suspend-target migration from among the identified user-specified migration and inter-tier page migration.

A user-specified migration (first volume migration) affected by either a storage apparatus **2** being stopped or a storage area being block may be called "affected user-specified migration", an inter-tier page migration (first page migration) affected by either a storage apparatus **2** being stopped or a storage area being blocked may be called "affected inter-tier page migration", and the affected user-specified migration and the affected inter-tier page migration may be called "affected migration".

The affected migration identification program **1231** (hereinafter written as "identification program **1231**") identifies an affected migration based on input information, which specifies either a stop-target storage apparatus **2** or a block-target storage area.

The user-specified migration change instruction program **1232** (hereinafter written as "UM change instruction program **1232**"), for example, performs a setting change with respect to the affected user-specified migration based on input data from the administrator.

The inter-tier page migration change instruction program **1233** (hereinafter written as "PM change instruction program **1233**"), for example, performs a setting change with respect to the affected inter-tier page migration based on input data from the administrator.

The migration suspend instruction program **1234** (hereinafter written as "suspend instruction program **1234**") suspends an affected migration, which is regarded as a suspend target.

The user-specified migration required time computation program **1235** (hereinafter written as "UM required time computation program **1235**") estimates the time required for an affected user-specified migration, and computes an expected date and time for the completion of the task, which executes the affected user-specified migration.

The inter-tier page migration required time computation program **1236** (hereinafter written as "PM required time computation program **1236**") estimates the time required until the completion of the execution of each cycle of the affected inter-tier page migration, and computes an expected date and time for the completion of the affected inter-tier page migration for each cycle.

The respective processing performed by the management computer **1** may be executed by the controller **20** of the storage apparatus **2**. That is, computer system management functions may be provided in the storage apparatus **2**. The functions of the management computer **1** may also be loaded into the host **3**.

The management-side physical page management information **126** is for the management computer **1** to manage whether or not the physical pages **271** of the respective RAID groups **262**, which exist in the computer system, have been allocated to the virtual volume **266**, and to consolidate the ST-side physical page management information **223** of the multiple storage apparatuses **2**, which exist in the computer system. The management-side physical page management information **126** comprises the information item storage apparatus ID **1261** in addition to the information items of the ST-side physical page management information **223**. The identifier of the storage apparatus **2** in which the RAID group **262** exists is stored in the storage apparatus ID **1261** of the management-side physical page management information **126**. The management computer **1** acquires the ST-side physical page management information **223** from each storage apparatus **2**, and creates the management-side physical page management information **126**. In the following explanation, each information item (other than the storage apparatus ID **1261**) of the management-side physical page management information **126** is identified using a reference number given to an information item of the ST-side physical page management information **223** for descriptive purposes.

The management-side logical volume management information **127** is for the management computer **1** to manage a relationship between a logical volume **264**, which exists in the computer system, and a physical page **271** included in this logical volume **264**, and to consolidate the ST-side logical volume management information **224** of the multiple storage apparatuses **2**, which exist in the computer system. The management-side logical volume management information **127** comprises the information item storage apparatus ID **1271** in addition to the information items of the ST-side logical volume management information **224**. The identifier of the storage apparatus **2** in which the logical volume **264** exists is stored in the storage apparatus ID **1271** of the management-side logical volume management information **127**. The management computer **1** acquires the ST-side logical volume management information **224** from each storage apparatus **2**, and creates the management-side logical volume management information **127**. In the following explanation, each information item (other than the storage apparatus ID **1271**) of the management-side logical volume management information **127** is identified using a reference number given to an information item of the ST-side logical volume management information **224** for descriptive purposes.

The management-side pool management information **129** is for the management computer **1** to manage the configuration of the pool **265**, which exists inside the computer system, and setting contents related to an inter-tier page migration performed in this pool **265**, and to consolidate the ST-side pool management information **226** of the multiple storage

apparatuses **2**, which exist in the computer system. The information items included in the management-side pool management information **129** are substantially the same as the information items included in the ST-side pool management information **226**. The management computer **1** acquires the ST-side pool management information **226** from each storage apparatus **2**, and creates the management-side pool management information **129**. In the following explanation, the management computer **1** uses a reference number given to an each information item of the ST-side pool management information **226** is identified using a reference number given to an information item of the management-side pool management information **129** for descriptive purposes.

FIG. **10** is a block diagram of an example of management-side RAID group management information related to the example 1.

The management-side RAID group management information **125** is for the management computer **1** to manage the configuration of the RAID group **262**, which exists in the computer system, and to consolidate the ST-side RAID group management information **222** of the multiple storage apparatuses **2**, which exist in the computer system. The management-side RAID group management information **125**, for example, is configured as a table, and comprises the information items RAID group ID **1251**, storage apparatus ID **1252**, device type **1253**, and RAID level **1254**.

The RAID group ID **1251**, the device type **1253**, and the RAID level **1254** correspond to the RAID group ID **2221**, the device type **2222**, and the RAID level **2223**, respectively, of the ST-side RAID group management information **222**. The identifier of the storage apparatus **2** in which the RAID group **262** exists is stored in the storage apparatus ID **1252**. The management computer **1** acquires the ST-side RAID group management information **222** from each storage apparatus **2**, and creates the management-side RAID group management information **125**.

FIG. **11** is a block diagram of an example of management-side virtual volume management information related to the example 1.

The management-side virtual volume management information **128** is for the management computer **1** to manage information related to the virtual segment **272** of the virtual volume **266**, which exists in the computer system, and the physical page **271** allocated to this virtual segment **272**, and to consolidate the ST-side virtual volume management information **225** of the multiple storage apparatuses **2**, which exist in the computer system. The management-side virtual volume management information **128**, for example, is configured as a table, and comprises the information items virtual volume ID (VVOL-ID) **1281**, storage apparatus ID **1282**, virtual segment ID **1283**, virtual volume LBA range (VVOL LBA range) **1284**, physical page ID **1285**, IOPS **1286**, and reallocation destination determination result **1287**.

The virtual volume ID **1281**, the virtual segment ID **1283**, the virtual volume LBA range **1284**, the physical page ID **1285**, and the reallocation destination determination result **1287** correspond to the virtual volume ID **2251**, the virtual segment ID **2252**, the virtual volume LBA range **2253**, the physical page ID **2254**, and the reallocation destination determination result **2257**, respectively, of the ST-side virtual volume management information **225**. The identifier of the storage apparatus **2**, which provides the virtual volume **266**, is stored in the storage apparatus ID **1282**. An average IOPS value for the virtual segment **272** is stored in the IOPS **1286**.

FIG. **12** is a block diagram of an example of tier management information related to the example 1.

The tier management information **124** is for managing the performance of each tier **2651** and a condition when allocating data to each tier **2651**. The tier management information **124**, for example, is updated in accordance with a request from the administrator. The tier management information **124**, for example, is configured as a table, and comprises the information items storage apparatus ID **1241**, tier ID **1242**, performance condition **1243**, and allocation condition **1244**.

The identifier of a storage apparatus **2** in which there exists a pool **265** comprising a tier **2651** is stored in the storage apparatus ID **1241**. The identifier of a tier **2651** is stored in the tier ID **1242**. In this example, the identifier of the high-level tier **2651**A (tier **1**) is "Tier **1**", the identifier of the mid-level tier **2651**B (tier **2**) is "Tier **2**", and the identifier of the low-level tier **2651**C (tier **3**) is "Tier **3**". Data showing a performance condition of a tier **2651** is stored in the performance condition **1243**. For example, data showing the type of the storage device **261** comprising the tier **2651**, the RAID level of the RAID group **262** comprising the tier **2651**, and whether or not the logical volume **264** comprising the tier **2651** is an external volume is included in the data showing the performance condition of the tier **2651**. Another performance parameter, such as access speed, may also be included in the data showing the performance condition of the tier **2651**.

Data showing a condition (hereinafter referred to as "allocation condition") for allocating data to a tier **2651** is configured in the allocation condition **1244**. The allocation condition, for example, is regarded as the range of the number of accesses per unit of time with respect to data allocated to this tier **2651**. In the example shown in FIG. **12**, data in which the average IOPS value is equal to or larger than 100 is allocated to the high-level tier **2651**A. Data in which the average IOPS value is equal to or larger than 30 but less than 100 is allocated to the mid-level tier **2651**B. Data in which the average IOPS value is less than 30 is allocated to the low-level tier **2651**C. The value of the allocation condition **1244** may be a fixed value or a variable value. In this example, IOPS is used to determine the allocation condition, but as long as an allocation destination can be determined based on a data access frequency per unit of time, any performance index (for example, IOPH or the like) is acceptable.

FIG. **13** is a block diagram of an example of host management information related to the example 1.

The host management information **120** is for managing a corresponding relationship between the host **3** and the virtual volume **266** and logical volume **264** accessed by the host **3**. The host management information **120**, for example, is configured as a table, and comprises the information items host **1201**, allocated volume **1202**, and storage apparatus **1203**.

The identifier of the host **3** is stored in the host **1201**. The identifier of either the logical volume **264** or the virtual volume **266**, which is allocated to the host **3**, that is, which is accessed by the host **3**, is stored in the allocated volume **1202**. The identifier of the storage apparatus **2** in which either the logical volume **264** or the virtual volume **266** allocated to the host **3** exists is stored in the storage apparatus **1203**. The host management information **120** is created based on host configuration information **323** acquired from the host **3**.

FIG. **14** is a block diagram of an example of user-specified migration task management information related to the example 1.

The user-specified migration task management information **131** is for managing a task (hereinafter referred to as "user-specified migration task") for executing a user-specified migration. The user-specified migration task management information **131**, for example, is configured as a table, and comprises the information items task ID **1311**, migration-

source volume **1312**, migration-source storage apparatus **1313**, migration-destination volume **1314**, migration-destination storage apparatus **1315**, sub-task status **1319**, task status **1316**, execution start date/time **1317**, and execution complete date/time **1318**.

The identifier of a user-specified migration task is stored in the task ID **1311**. The identifier of a migration-source volume of the user-specified migration executed by the user-specified migration task is stored in the migration-source volume **1312**. The identifier of the storage apparatus **2** (hereinafter referred to as "migration-source storage apparatus") in which exists the migration-source volume of the user-specified migration executed by the user-specified migration task is stored in the migration-source storage apparatus **1313**. The identifier of a migration-destination volume of the user-specified migration executed by the user-specified migration task is stored in the migration-destination volume **1314**. The identifier of the storage apparatus **2** (hereinafter referred to as "migration-destination storage apparatus") in which exists the migration-destination volume of the user-specified migration executed by the user-specified migration task is stored in the migration-destination storage apparatus **1315**. Data showing the state of a sub-task of the user-specified migration task is stored in the sub-task status **1319**. The type of data showing the sub-task status is the same as the type of data showing the status of the task. Data, for example, "executing", "waiting", "execution complete", and so forth, which shows the status of the user-specified migration task, is stored in the task status **1316**. Data showing the date and time at which the execution of the user-specified migration task started is stored in the execution start date/time **1317**. Data showing the date and time at which the execution of the user-specified migration task was completed is stored in the execution completion date/time **1318**.

The user-specified migration task is able to collectively execute multiple related user-specified migrations. In the example of the drawing, a user-specified migration task having the task ID **1311** of "VM1" is a task for collectively performing three user-specified migrations, that is, a user-specified migration from the logical volume "LVOL **1**" to the logical volume "LVOL **10**", a user-specified migration from the logical volume "LVOL **2**" to the logical volume "LVOL **11**", and a user-specified migration from the logical volume "LVOL **3**" to the logical volume "LVOL **12**".

In this example, an individual user-specified migration included in the user-specified migration task is regarded as the above-mentioned "sub-task". That is, in the example of the drawing, the task having the task ID "VM1" in comprises three sub-tasks. In the user-specified migration task management information in this example, the task execution status is managed in sub-task units.

FIG. **15** is a block diagram of an example of user-specified migration execution history information related to the example 1.

The user-specified migration execution history information **132** is for managing the execution history of user-specified migrations executed in the past for each storage apparatus **2**, specifically, a total value of the execution time for the user-specified migrations and a total value of the amount of data migrated in accordance with the user-specified migrations. The user-specified migration execution history information **132** is referenced when the UM required time computation program **1235** estimates the time, which will be required for a user-specified migration. The user-specified migration execution history information **132**, for example, is configured as a table, and comprises the information items storage apparatus ID **1321**, total value of execution time periods **1322**, and total value of migration data amounts **1323**.

The identifier of a storage apparatus **2** is stored in the storage apparatus ID **1321**. A total value of the execution time of user-specified migrations executed within a specified period in the past in the storage apparatus **2** is stored in the total value of execution time periods **1322**. As used here, a specified period in the past may be the total time period after an initial user-specified migration was executed in the storage apparatus **2** until the most recently performed user-specified migration was completed, for example, may be a one-year period in the past calculated from the point in time at which the execution of a migration suspend process, which will be explained further below, was started. A total value of the amount of data migrated in accordance with the user-specified migrations executed within a specified period in the past in the storage apparatus **2** is stored in the total value of migration data amounts **1323**.

Next, the inter-tier page migration execution history information **133** related to the example 1 will be explained.

The inter-tier page migration execution history information **133** is for managing the execution history of inter-tier page migrations executed in the past for each storage apparatus **2**, specifically, a total value of the execution time for the inter-tier page migrations and a total value of the amount of data migrated in accordance with the inter-tier page migrations. The inter-tier page migration execution history information **133** is referenced when the PM required time computation program **1236** estimates the time needed for an inter-tier page migration. The information items comprising the inter-tier page migration execution history information **133** are substantially the same as the information items comprising the user-specified migration execution history information **132**. In the following explanation, each information item of the inter-tier page migration execution history information **133** is identified using a reference number given to an information item of the user-specified migration execution history information **132** for descriptive purposes.

A total value of the execution time of inter-tier page migrations executed within a specified period in the past in the storage apparatus **2** is stored in the total value of execution time periods **1322** of the inter-tier page migration execution history information **133**. A total value of the amount of data migrated in accordance with the inter-tier page migrations executed within a specified period in the past in the storage apparatus **2** is stored in the total value of migration data amounts **1323** of the inter-tier page migration execution history information **133**.

Next, the operation of the storage apparatus **2** related to the example 1 will be explained. In the drawings, the storage apparatus **2** may be written as "DKC".

(1-1) Virtual Volume Read Process

FIG. **16** is a flowchart of a read process with respect to a virtual volume related to the example 1.

First, the storage control program **221** receives a read request (read command) with respect to the virtual volume **266** from the host **3** (Step S**101**). The storage control program **221** identifies a virtual segment **272** (hereinafter referred to as "read-target virtual segment"), which is the data read target, based on access destination information included in the read request (Step S**102**).

Next, the storage control program **221** determines whether or not the read-target data, that is, the data in the read-target virtual segment exists in the cache memory (Step S**103**).

In a case where the read-target data exists in the cache memory (Step S**103**: YES), the storage control program **221** sends the read-target data in the cache memory to the host **3** (Step S**108**) and advances the processing to Step S**109**.

Alternatively, in a case where the read-target data does not exist in the cache memory (Step S103: NO), the storage control program 221 identifies the physical page 271 (hereinafter referred to as "read-target physical page") allocated to the read-target virtual segment identified in Step S102 based on the ST-side virtual volume management information 225 (Step S104).

Thereafter, the storage control program 221 references the ST-side logical volume management information 224 and determines whether or not the read-target physical page belongs to an external storage apparatus, that is, belongs to either the second storage apparatus 2B or the third storage apparatus 2C (Step S105).

In a case where the read-target segment does not belong to an external storage apparatus, that is, a case in which the read-target physical page belongs to the first storage apparatus 2A (Step S105: NO), the storage control program 221 reads data from the read-target physical page of the first storage apparatus 2A, and writes the data, which has been read, to the cache memory (Step S106). Thereafter, the storage control program 221 sends the data, which was written to the cache memory, to the host 3 (Step S108) and advances the processing to Step S109.

Alternatively, in a case where the read-target physical page belongs to an external storage apparatus, that is, belongs to either the second storage apparatus 2B or the third storage apparatus 2C (Step S105: YES), the storage control program 221 transfers the read command to the storage apparatus 2 to which the read-target physical page belongs, and waits until the data of the read-target physical page is received from the relevant storage apparatus 2. The storage control program 221, upon receiving the read-target physical page data, writes the received read-target physical page data to the cache memory (Step S107). Thereafter, the storage control program 221 sends the data, which was written to the cache memory, to the host 3 (Step S108) and advances the processing to Step S109.

After sending the read-target data to the host 3 in Step S108, the storage control program 221 updates the number of accesses 2255 corresponding to the read-target virtual segment in the ST-side virtual volume management information 225 (Step S109). Thereafter, the storage control program 221 ends the read process with respect to the virtual volume.

(1-2) Logical Volume Read Process

A read process with respect to the logical volume related to the example 1 will be explained below.

First, the storage control program 221 receives a read request (read command) with respect to the logical volume 264 from the host 3 (Step S2101). The storage control program 221 identifies a physical page 271 (hereinafter referred to as "read-target physical page"), which is the data read target, based on access destination information included in the read request (Step S2102).

Next, the storage control program 221 determines whether or not the read-target data, that is, the data of the read-target physical page exists in the cache memory (Step S2103).

In a case where the read-target data exists in the cache memory (Step S2103: YES), the storage control program 221 sends the read-target data in the cache memory to the host 3 (Step S2104). Thereafter, the storage control program 221 ends the read process with respect to the logical volume.

Alternatively, in a case where the read-target data does not exist in the cache memory (Step S2103: NO), the storage control program 221 references the ST-side logical volume management information 224 and determines whether or not the read-target physical page belongs to an external storage apparatus, that is, either the second storage apparatus 2B or the third storage apparatus 2C (Step S2105).

In a case where the read-target physical page does not belong to an external storage apparatus, that is, a case in which the read-target physical page belongs to the first storage apparatus 2A (Step S2105: NO), the storage control program 221 reads data from the read-target physical page of the first storage apparatus 2A, and writes the data, which has been read, to the cache memory (Step S2106). Thereafter, the storage control program 221 sends the data, which was written to the cache memory, to the host 3 (Step S2107). Thereafter, the storage control program 221 ends the read process with respect to the logical volume.

Alternatively, in a case where the read-target physical page belongs to an external storage apparatus, that is, belongs to either the second storage apparatus 2B or the third storage apparatus 2C (Step S2105: YES), the storage control program 221 transfers the read command to the storage apparatus 2 to which the read-target physical page belongs, and waits until the data of the read-target physical page is received from the relevant storage apparatus 2. The storage control program 221, upon receiving the read-target physical page data, writes the received read-target physical page data to the cache memory (Step S2108). Thereafter, the storage control program 221 sends the data, which was written to the cache memory, to the host 3 (Step S2109). Thereafter, the storage control program 221 ends the read process with respect to the logical volume.

(2-1) Virtual Volume Write Process

FIG. 17 is a flowchart of a write process with respect to the virtual volume related to the example 1.

First, the storage control program 221, upon receiving a write request with respect to the virtual volume 266 from the host 3 (Step S201), identifies the virtual segment 272 (hereinafter referred to as "write-target virtual segment"), which is the destination for writing the data, based on access destination information included in the write request (Step S202).

Next, the storage control program 221 determines whether or not a physical page 271 is allocated to the write-target virtual segment (Step S203). Specifically, the storage control program 221 determines whether or not an entry related to the write-target virtual segment is registered in the ST-side virtual volume management information 225.

In a case where a physical page 271 is allocated to the write-target virtual segment (Step S203: YES), the storage control program 221 references the ST-side virtual volume management information 225 and the ST-side logical volume management information 224, and determines whether or not the physical page 271 (hereinafter referred to as "write-target physical page") allocated to the write-target virtual segment belongs to an external storage apparatus, that is, belongs to either the second storage apparatus 2B or the third storage apparatus 2C (Step S204).

In a case where the write-target physical page does not belong to an external storage apparatus, that is, a case in which the write-target physical page belongs to the first storage apparatus 2A (Step S204: NO), the storage control program 221 writes the write-target data to the write-target physical page (Step S206) and advances the processing to Step S212.

Alternatively, in a case where the write-target physical page belongs to an external storage apparatus, that is, belongs to either the second storage apparatus 2B or the third storage apparatus 2C (Step S204: YES), the storage control program 221 transfers the write command to the storage apparatus 2 to which the write-target physical page belongs, has the write-

target data written to the write-target physical page of the relevant storage apparatus **2** (Step S**205**) and advances the processing to Step S**212**.

In a case where a physical page **271** is not allocated to the write-target virtual segment (Step S**203**: NO), the storage control program **221** determines whether or not a physical page **271** capable of being allocated to the write-target virtual segment, that is, an unallocated physical page **271** exists (Step S**207**). Specifically, the storage control program **221** determines whether or not there exists a physical page **271** for which the allocation status **2234** of the ST-side physical page management information **223** is configured to "unallocated".

In a case where a physical page **271** capable of being allocated to the write-target virtual segment exists (Step S**207**: YES), the storage control program **221** determines whether the unallocated physical page **271** belongs to the internal storage apparatus or an external storage apparatus (Step S**208**).

In a case where the unallocated physical page **271** belongs to the internal storage apparatus (Step S**208**: own DKC), the storage control program **221** allocates the unallocated physical page **271** to the write-target virtual segment, writes the write-target data to this physical page **271** (Step S**210**), and advances the processing to Step S**212**.

Alternatively, in a case where the unallocated physical page **271** belongs to an external storage apparatus (Step S**208**: other DKC), after allocating the unallocated physical page **271** to the write-target virtual segment, the storage control program **221** transfers the write command to the storage apparatus **2** to which the relevant allocated physical page **271** belongs, has the write-target data written to the relevant allocated physical page **271** (Step S**209**), and advances the processing to Step S**212**.

After writing the write-target data in Steps S**205**, S**206**, S**209** or S**210**, the storage control program **221** updates the value of the number of accesses **2255** corresponding to the write-target virtual segment in the ST-side virtual volume management information **225** (Step S**212**). Thereafter, the storage control program **221** ends the write process with respect to the virtual volume.

In a case where a physical page **271** capable of being allocated to the write-target virtual segment does not exist in Step S**207** (Step S**207**: NO), the storage control program **221** sends an error to the host **3** (Step S**211**) and ends the processing with respect to the virtual volume.

(2-2) Logical Volume Write Process

A write process with respect to the logical volume related to the example 1 will be explained below. In the following explanation, step numbers will be given to the processes as needed to make for easier reading. The number **2201** and subsequent numbers are not given in the drawings as step numbers.

First, the storage control program **221**, upon receiving a write request with respect to the logical volume **264** from the host **3** (Step S**2201**), identifies the physical page **271** (write-target physical page), which is the destination for writing the data, based on access destination information included in the write request (Step S**2202**).

Next, the storage control program **221** references the ST-side logical volume management information **224**, and determines whether or not the write-target physical page belongs to an external storage apparatus, that is, belongs to either the second storage apparatus **2**B or the third storage apparatus **2**C (Step S**2203**).

In a case where the write-target physical page does not belong to an external storage apparatus, that is, a case in which the write-target physical page belongs to the first storage apparatus **2**A (Step S**2203**: NO), the storage control program **221** writes the write-target data to the write-target physical page (Step S**2204**). Thereafter, the storage control program **221** ends the write process with respect to the logical volume.

Alternatively, in a case where the write-target physical page belongs to an external storage apparatus, that is, belongs to either the second storage apparatus **2**B or the third storage apparatus **2**C (Step S**2203**: YES), the storage control program **221** transfers the write command to the storage apparatus **2** to which the write-target physical page belongs and has the write-target data written to the write-target physical page of the relevant storage apparatus **2** (Step S**2205**). Thereafter, the storage control program **221** ends the processing with respect to the logical volume.

(3) Volume Migration Process

A volume migration process related to the example 1 will be explained below.

The data migration program **2213**, upon receiving an instruction from the management computer **1** to execute a volume migration (for example, a user-specified migration) in which a migration-source volume and a migration-destination volume are specified, copies data of the migration-source volume to the migration-destination volume (Step S**2301**).

Next, the data migration program **2213** interchanges the configuration control information of the migration-source volume with the configuration control information of the migration-destination volume (Step S**2302**). The volume configuration control information here, for example, is the identifier of the logical volume **264**.

Thereafter, the data migration program **2213** notifies the management computer **1** that the volume migration has been completed (Step S**2303**), and ends the volume migration process.

According to the volume migration, the data of the migration-source volume is migrated to the migration-destination volume in a state in which an I/O request from the host **3** can be processed as-is. The migration-source volume and the migration-destination volume may be logical volumes **264** inside the same storage apparatus **2**, or may be logical volumes **264** inside different storage apparatuses **2**. That is, a data migration may be performed between two logical volumes **264** inside a certain one storage apparatus **2**, or a data migration may be performed between logical volumes **264** respectively inside two different storage apparatus **2** (for example, either an external storage apparatus and the internal storage apparatus, or the two external storage apparatuses).

Next, the operation of the management computer **1** related to the example 1 will be explained.

(4) Migration Task Management Process

FIG. **18** is a flowchart of the migration task management process related to the example 1.

First, the migration task management program **122** acquires the current date and time (Step S**301**).

The migration task management program **122** executes the processing of Steps S**302** through S**306** for each user-specified migration task registered in the user-specified migration task management information **131**. A processing-target user-specified migration task will be called "target task" hereinbelow.

The migration task management program **122** references the user-specified migration task management information **131** and determines whether or not the target task is a waiting-to-execute state, that is, the task status **1316** of the target task is configured to "waiting", and, in addition, the value of the

target task execution start date/time **1317** is showing either the current date/time or a date/time prior to the current date/time (Step S**303**).

In a case where the target task is a waiting-to-execute state, and, in addition, the value of the target task execution start date/time **1317** is showing either the current date/time or a date/time prior to the current date/time (Step S**303**: YES), the migration task management program **122** executes the target task (Step S**304**). Specifically, the migration task management program **122** references the user-specified migration task management information **131**, identifies information (migration-source volume, migration-source storage apparatus, migration-destination volume, and migration-destination storage apparatus) related to the user-specified migration to be executed in accordance with the target task, and instructs the migration-source storage apparatus and/or the migration-destination storage apparatus to execute the user-specified migration from the migration-source volume to the migration-destination volume. In a case where the target task collectively executes multiple user-specified migrations, the migration task management program **122** instructs the execution thereof to the target storage apparatus (es) **2** for each of the multiple user-specified migrations.

Thereafter, the migration task management program **122** configures the task status **1316** of the target task to "executing" and configures the current date/time in the execution start date/time **1317** of the target task in the user-specified migration management information **131** (Step S**305**).

Alternatively, in a case where either the target task is not in the waiting-to-execute state, or the value of the execution start date/time **1317** of the target task shows a date/time after the current date/time (Step S**303**: NO), the migration task management program **122** does not execute the target task.

The migration task management program **122** waits for a fixed period of time after ending the execution of the processing of Steps S**302** through S**306** for each user-specified migration task registered in the user-specified migration task management information **131** (Step S**307**).

Thereafter, when the executed user-specified migration task has been completed, that is, when a notification indicating that the task-executed user-specified migration (all of the user-specified migrations in the case of multiple user-specified migration,) is complete has been received from the storage apparatus **2** (Step S**308**: YES), the migration task management program **122** acquires the current date and time. Then the migration task management program **122** changes the task status **1316** of the completed task to "execution complete" in the user-specified migration task management information **131**, and configures the acquired current date/time in the execution completion date/time **1318** for the completed task (Step S**309**). "When the user-specified migration task has been completed" signifies a case in which at the least one sub-task of multiple sub-tasks (for example, all sub-tasks) has been completed when the user-specified migration task comprises multiple sub-tasks. In Step S**309**, in a case where the sub-task status **1319** of a completed sub-task is changed to "normal completion", and, in addition, the statuses **1319** of all the sub-tasks comprising the user-specified migration task transition to "normal completion" for a single user-specified migration task, the task status **1316** of the relevant user-specified migration task changes to "execution completion".

Thereafter, the migration task management program **122** reflects the actual value of the user-specified migration(s) for which execution has been completed in the user-specified execution history information **132** (Step S**310**). Specifically, the migration task management program **122** adds the time required for the execution-completed user-specified migration(s) to the total value of execution time periods **1322**, and adds the amount of data migrated in accordance with the execution-completed user-specified migration to the total value of migration data amounts **1323**. The amount of data migrated in accordance with the user-specified migration, for example, is computed by multiplying the storage size of one LBA (for example, 512 bytes) by the total number of LBAs of the physical page **271** included in the migration-source volume. The time required for the user-specified migration, for example, is computed by subtracting the date/time shown in the execution start date/time **1317** from the date/time shown in the execution completion date/time **1318** of the corresponding user-specified migration task. In a case where the user-specified migration task comprises multiple sub-tasks, the date/time shown in the execution completion date/time **1318** of the user-specified migration task may be the execution completion date/time of the sub-task for which execution was completed last among the multiple sub-tasks, and the date/time shown in the execution start date/time **1317** may be the execution start date/time of the sub-task for which execution was started first among the multiple sub-tasks.

Either after ending the processing of Step S**310**, or when a notification indicating that a task-executed user-specified migration has been completed is not received from the storage apparatus **2** (Step S**308**: NO), the migration task management program **122** determines whether or not an end-program instruction has been received (Step S**311**).

In a case where an end-program instruction has not been received (Step S**311**: NO), the migration task management program **122** moves the processing to Step S**301**. That is, the migration task management program **122** once again performs the processing of Steps S**301** through S**311**. The migration task management program **122** repeatedly executes the processing of Steps S**301** through **311** until the end-program instruction is received, for example, for a fixed time interval.

Alternatively, in a case where the end-program instruction has been received (Step S**311**: YES), the migration task management program **122** ends the migration task management process.

FIG. **19** is a block diagram of an example of a user-specified migration registration screen related to the example 1.

The user-specified migration registration screen **51** is a screen for receiving from the administrator the registration of a user-specified migration task to be executed in the migration task management process. The management computer **1** registers the contents of the registered user-specified migration task in the user-specified migration task management information **131** via the user-specified migration registration screen **51**.

The user-specified migration registration screen **51** comprises an area **511** for receiving the input of a setting item related to a user-specified migration task, and an area **512** for displaying the contents of the user-specified migration to be executed in accordance with the user-specified migration task. The setting items related to the user-specified migration task, for example, comprise a task name, a task execution start date/time, and information related to a user-specified migration to be executed in accordance with the task (migration-source volume, migration-source storage apparatus, migration-destination volume, and migration-destination storage apparatus).

(5) Migration Suspend Process

A migration suspend process related to the example 1 will be explained below.

The suspend program **123** starts the execution of migration suspend processing in a case where a specification of either a

stop-target storage apparatus **2** or a block-target storage area and an instruction to execute the migration suspend process has been received from the administrator on a migration suspend screen (refer to FIG. **20**), which will be explained further below.

First, the suspend program **123** has the identification program **1231** execute an affected migration identification process (refer to FIG. **21**) (Step S**2401**). An affected migration is identified in accordance with the affected migration identification process.

Next, the suspend program **123** has the UM required time computation program **1235** execute a user-specified migration required time computation process (Step S**2402**). An expected completion date/time for a user-specified migration task for executing an affected user-specified migration is computed in accordance with the user-specified migration required time computation process (refer to FIG. **28**).

Next, the suspend program **123** has the PM required time computation program **1236** execute a inter-tier page migration required time computation process, which will be explained further below (Step S**2403**). An expected completion date/time for an affected inter-tier page migration is computed in accordance with the inter-tier page migration required time computation process.

Thereafter, the suspend program **123** displays information related to the affected migration on the migration suspend screen (refer to FIG. **20**) (Step S**2404**). The suspend program **123** can receive an instruction to change a setting with respect to the affected migration via a change action screen (refer to FIGS. **23** and **25**), which is booted from the migration suspend screen and will be explained further below.

As a setting change with respect to the affected migration, for example, there is the changing of an action with respect to the affected migration, and the changing of a post-suspend migration policy of the affected migration (at least one of a user-specified migration and an inter-tier page migration, which will be affected). As an action with respect to the affected migration, for example, there is a "suspend", which suspends the affected migration, and a "resume", which resumes the processing by changing the processing contents of the affected migration (for example, the migration-destination volume). For example, the memory **12** stores data showing an action with respect to each affected migration. The initial value of the action with respect to each affected migration may be uniformly set to "suspend" for all the actions, or, for example, an affected migration of high importance may be set to "resume" and an affected migration, which is not so important, may be set to "suspend". In this example, the importance of each migration (user-specified migration and inter-tier page migration), for example, is stored in the memory **12**. The post-suspend migration policy of the affected inter-tier page migration refers to a policy showing how data stored in a storage area, which has become inaccessible in a case where a storage apparatus **2** has been stopped or a storage area has been blocked, is to be migrated to an accessible area. In this example, as the setting change with respect to the affected user-specified migration, it is supposed that an action is changed, and as the setting change with respect to the affected inter-tier page migration, it is supposed that the post-suspend migration policy is changed.

The "migration importance" here, for example, is based either on the importance of a host, which has an allocation to the migration-target volume (migration-source volume) of the user-specified migration (that is, the host, which accesses the migration-target volume), or the importance of a host, which has an allocation to a virtual volume related to an inter-tier pool, which is the implementation target of the inter-tier page migration. Then, "host importance", for example, may be the importance of an application running on the relevant host, and the host importance (for example, the importance of the application running on the relevant host) may be configured via a management screen of the management computer.

In a case where an instruction to change a setting with respect to the affected user-specified migration has been received, the suspend program **123** has the UM change instruction program **1232** execute a user-specified migration change instruction process (refer to FIG. **22**) (Step S**2405**). A setting change with respect to the target affected user-specified migration (an action change) is performed in accordance with the user-specified migration change instruction process.

In a case where an instruction to change a setting with respect to the affected inter-tier page migration has been received, the suspend program **123** has the PM change instruction program **1233** execute an inter-tier page migration change instruction process (refer to FIG. **24**) (Step S**2406**). A setting change with respect to the target affected inter-tier page migration (a post-suspend migration policy change) is performed in accordance with the inter-tier page migration change instruction process.

Thereafter, in a case where an instruction to execute an action with respect to the affected migration has been received from the administrator via the migration suspend screen (FIG. **20**), the suspend program **123** executes the action with respect to the affected migration, that is, suspends the affected migration, which is regarded as the suspend target.

Specifically, the suspend program **123** has the suspend instruction program **1234** execute a user-specified migration suspend instruction process (refer to FIG. **26**) (Step S**2407**). The affected user-specified migration regarded as the suspend target, that is, the affected user-specified migration for which the action is configured to "suspend" is suspended in accordance with the user-specified migration suspend instruction process.

The suspend program **123** has the suspend instruction program **1234** execute an inter-tier page migration suspend instruction process (refer to FIG. **27**) (Step S**2408**). The affected inter-tier page migration regarded as the stop target, that is, the affected inter-tier page migration for which the action is configured to "suspend" is suspended in accordance with the inter-tier page migration suspend instruction process.

FIG. **20** is a block diagram of an example of a migration suspend screen related to the example 1.

The migration suspend screen **52** is a screen for displaying various information related to migration suspend processing and receiving an instruction from the administrator. The management computer **1** receives a specification of either a stop-target storage apparatus **2** or a block-target storage area, and an instruction for executing a migration suspend process via the migration suspend screen **52**. The management computer **1** displays information related to an affected migration on the migration suspend screen **52**.

The migration suspend screen **52** comprises an area **521** for receiving a specification of either a stop-target storage apparatus **2** or a block-target storage area, and an instruction for executing an affected migration identification process, an area **522** for displaying information related to the affected migration, and an action execution button **523** for receiving an instruction to execute an action with respect to the affected migration. In this example, the specification of a block-target storage area, for example, is performed in RAID group **262**

units. That is, the entire storage area included in a RAID group **262** specified in the area **521** constitutes the target of a block.

The specification of the block-target storage area in this example is performed in RAID group units, but as another specification method, this specification may be performed in storage device units or logical volume units.

When either a stop-target storage apparatus **2** or a block-target storage area is specified in the area **521** and an affected range identification start button **5212** is pressed, the management computer **1** starts to execute affected migration identification process. Thereafter, the management computer **1** displays information related to the affected migration in the area **522** in the Step S**2404** of the migration suspend processing.

In the area **522**, information **5221** related to an affected user-specified migration and information **5222** related to an affected inter-tier page migration, for example, are displayed using tables. The information **5221** related to the affected user-specified migration comprises a migration-source storage apparatus and a migration-source volume (Migration Source), a migration-destination storage apparatus and a migration-destination volume (Migration Target), migration destination selection policy for the affected volume, a post-change new migration-destination storage apparatus and migration-destination volume when resuming the affected user-specified migration (New Migration Target), an affected host **3**, a task status, an expected task completion date/time, and an importance of the affected user-specified migration. The information **5222** related to the affected inter-tier page migration comprises a related pool **265** identifier, migration destination selection policy for the affected physical page **271**, an affected host **3**, an execution status of the affected inter-tier page migration, an expected completion date-time for the affected inter-tier page migration, and an importance of the affected inter-tier page migration. The expected task completion date/time is computed in a user-specified migration required time computation process for each task executing an affected user-specified migration. The expected completion date/time for the inter-tier page migration is computed in an inter-tier page migration required time computation process for each affected inter-tier page migration. The affected host **3** refers to the host **3**, which accesses a volume related to an affected migration, and is identified based on the host management information **120**. The volume related to an affected migration includes a migration-source volume of an affected user-specified migration, and a virtual volume **266** associated with the pool **265** in which an affected inter-tier page migration is performed.

When the change action button **5223** is pressed in the area **522**, the suspend program **123** displays a user-specified migration action change screen **53** (FIG. **23**). The management computer **1** receives an instruction from the administrator to change a setting with respect to the affected user-specified migration via the user-specified migration action change screen **53**. When the change action button **5224** is pressed in the area **522**, the suspend program **123** displays an inter-tier page migration action change screen **54** (FIG. **25**). The management computer **1** receives an instruction from the administrator to change a setting with respect to the affected inter-tier page migration via the inter-tier page migration action change screen **54**.

When the execute action button **523** is pressed, the management computer **1** executes the action with respect to the affected migration, that is, suspends the affected migration, which is regarded as the suspend target.

Thus, in accordance with the information related to the affected migration being displayed on the migration suspend screen **52**, the administrator is able to check the contents of the affected migration prior to stopping the storage apparatus **2** or blocking the storage area. For example, the contents of the action with respect to each affected migration may be displayed in the area **522**. In accordance with displaying the contents of the action with respect to each affected migration, the administrator is able to check the contents of the action with respect to each affected migration, and to review whether or not to change the action based on the checked contents.

In accordance with the expected task completion date/time and the expected completion date/time of the inter-tier page migration being displayed in the area **522**, the administrator, for example, is able to learn about how long to wait in a case where either the storage apparatus **2** will be stopped or the storage area will be blocked after waiting for the affected migration to be completed. That is, the administrator is able to either stop the storage apparatus **2** or block the storage area systematically. In accordance with the importance of an affected migration being displayed in the area **522**, it is possible to either stop the storage apparatus **2** or block the storage area after waiting for the affected migration to be completed with respect to a highly important affected migration in particular.

(5-1) Affected Migration Identification Process

FIG. **21** is a flowchart of an affected migration identification process related to the example 1.

The identification program **1231** receives a parameter showing either a stop-target storage apparatus **2** or a block-target RAID group **262** specified by the administrator at the start of affected migration identification process execution (Step S**401**).

The identification program **1231** executes the processing of Steps S**402** through S**406** with respect to each user-specified migration task registered in the user-specified migration task management information **131**. The user-specified migration task, which is the target of the processing, will be called the "target task" hereinbelow.

The identification program **1231** references the user-specified migration task management information **131** and determines whether or not the target task is an executing state or a waiting-to-execute state, that is, whether or not the task status **1316** of the target task is configured to "executing" or "waiting" (Step S**403**).

In a case where the target task is either an executing state or a waiting-to-execute state (Step S**403**: YES), the identification program **1231** determines whether or not the user-specified migration to be executed in accordance with the target task (hereinafter referred to as "target user-specified migration") is related to a stop-target storage apparatus **2** or a block-target RAID group **262** (Step S**404**). As used here, the expression user-specified migration is related to stop-target storage apparatus **2** refers to the fact that either the migration-source storage apparatus or the migration-destination storage apparatus of the user-specified migration corresponds to the stop-target storage apparatus **2**. Furthermore, the expression user-specified migration is related to block-target RAID group **262** refers to the fact that any of the physical pages **271** comprising either the migration-source volume or the migration-destination volume of the user-specified migration are included in the block-target RAID group **262**. The identification program **1231**, in a case where the parameter received in Step S**401** shows a stop-target storage apparatus **2**, determines whether or not the target user-specified migration is related to the stop-target storage apparatus **2**, and in a case where the parameter received in Step S**401** shows a block-

target RAID group **262**, determines whether or not the target user-specified migration is related to the block-target RAID group **262**.

Specifically, the identification program **1231** references the migration-source storage apparatus **1313** and the migration-destination storage apparatus **1315** of the user-specified migration task management information **131**, identifies the migration-source storage apparatus and the migration-destination storage apparatus related to the target user-specified migration, and determines whether or not these storage apparatuses correspond to the stop-target storage apparatus **2**. The identification program **1231** references the migration-source volume **1312** and the migration-destination volume **1314** of the user-specified migration task management information **131** and identifies the migration-source volume and the migration-destination volume related to the target user-specified migration. Then, the identification program **1231** references the logical volume ID **2241** and the physical page ID **2242** of the management-side logical volume management information **127**, and the RAID group ID **2231** and the physical page ID **2232** of the management-side physical page management information **126**, and, in accordance with determining whether or not any of the physical pages **271** comprising either the identified migration-source volume or migration-destination volume correspond to any of the physical pages **271** included in the block-target RAID group **262**, determines whether or not any of the physical pages **271** comprising either the identified migration-source volume or migration-destination volume are included in the block-target RAID group **262**.

In a case where the target user-specified migration is related to either the stop-target storage apparatus **2** or the block-target RAID group **262** (Step S**404**: YES), the identification program **1231** identifies the target user-specified migration as an affected user-specified migration (Step S**405**).

Alternatively, in a case where the target task is neither an executing state nor a waiting-to-execute state (Step S**403**: NO), or the parameter received in Step S**401** shows a stop-target storage apparatus **2** but the target user-specified migration is not related to the stop-target storage apparatus **2**, or the parameter received in Step S**401** shows a block-target RAID group **262** but the target user-specified migration is not related to the block-target RAID group **262** (Step S**404**: NO), the identification program **1231** does not identify the target user-specified migration as an affected user-specified migration.

The identification program **1231**, after ending the execution of the processing of Steps S**402** through S**406** for each of the user-specified migration tasks registered in the user-specified migration task management information **131**, executes the processing of Steps S**407** through S**410** with respect to each of the pools **265** for which inter-tier page migration is valid among the pools **265** registered in the management-side pool management information **129**, that is, the pools **265** for which the inter-tier page migration **2264** is configured to "ON". A processing-target pool **265** will be called "target pool" hereinbelow.

The identification program **1231** determines whether or not the target pool is related to either the stop-target storage apparatus **2** or the block-target RAID group **262**. As used here, the expression pool **265** is related to the stop-target storage apparatus **2** refers to the fact that a logical volume **264** belonging to the stop-target storage apparatus **2** is included among the logical volumes **264** comprising the pool **265**. Furthermore, the expression pool **265** is related to the block-target RAID group **262** refers to the fact that a logical volume **264** related to the block-target RAID group **262** is included among the logical volumes **264** comprising the pool **265**. A logical volume **264** related to the block-target RAID group **262** here is a logical volume **264** corresponding to a LU **263** disposed in the block-target RAID group **262**, and is a logical volume **264**, which is comprised of physical pages **271** included in the block-target RAID group **262**. The identification program **1231**, in a case where the parameter received in Step S**401** shows a stop-target storage apparatus **2**, determines whether or not the target pool is related to the stop-target storage apparatus **2**, and in a case where the parameter received in Step S**401** shows a block-target RAID group **262**, determines whether or not the target pool is related to the block-target RAID group **262**.

Specifically, the identification program **1231** references the storage apparatus ID **1271** and the logical volume ID **2241** of the management-side logical volume management information **127**, and identifies the logical volume **264**, which exists in the stop-target storage apparatus **2**. The identification program **1231** also references the logical volume ID **2241** and the physical page ID **2242** of the management-side logical volume management information **127**, and the RAID group ID **2231** and the physical page ID **2232** of the management-side physical page management information **126** and identifies the logical volume **264** related to the block-target RAID group **262**. Then, the identification program **1231** references the pool ID **2261** and the pool configuration logical volume ID **2262** of the management-side pool management information **129** and determines whether or not the identified logical volume **264** is a logical volume **244** comprising the target pool.

In a case where the target pool is related to either the stop-target storage apparatus **2** or the block-target RAID group **262** (Step S**408**: YES), the identification program **1231** identifies an inter-tier page migration performed by the target pool as an affected inter-tier page migration (Step S**409**).

Alternatively, in a case where the parameter received in Step S**401** shows a stop-target storage apparatus **2** but the target pool is not related to the stop-target storage apparatus **2**, or the parameter received in Step S**401** shows a block-target RAID group **262** but the target pool is not related to the block-target RAID group **262** (Step S**408**: NO), the identification program **1231** does not identify the inter-tier page migration performed by the target pool as an affected inter-tier page migration.

The identification program **1231**, after ending the execution of the processing of Steps S**407** through S**410** with respect to each pool **265** for which the inter-tier page migration is valid from among the pools **265** registered in the management-side pool management information **129**, ends the affected migration identification process.

(5-2) User-Specified Migration Change Instruction Process

FIG. **22** is a flowchart of a user-specified migration change instruction process related to the example 1.

At the start of user-specified migration change instruction processing, the UM change instruction program **1232** receives a parameter, which comprises the identifier of an affected user-specified migration, which is targeted for a setting change (an action change) (hereinafter referred to as "target affected UM" in the explanation of FIG. **22**), and information showing the content of a setting change inputted by the administrator in the user-specified migration action change screen **53** (refer to FIG. **23**) (Step S**501**). The information showing the contents of the setting change, for example, comprises information showing whether the change is from "suspend" to "resume", or from "resume" to "suspend", and information for identifying the post-change

migration-destination storage apparatus and the migration-destination volume in a case where the target affected UM is to resume.

First, the UM change instruction program **1232** determines whether or not the setting change with respect to the target affected UM is an action change from "suspend" to "resume" (Step S**502**).

In a case where the setting change with respect to the target affected UM is not an action change from "suspend" to "resume", that is, a case in which the setting change is an action change from "resume" to "suspend" (Step S**502**: NO), the UM change instruction program **1232** receives a setting related to a post-migration suspend migration policy when the migration of a portion of the data in the migration-source volume has already been completed to the affected volume (the logical volume to be affected by the DKC stop/RAID group block) (Step S**509**). Then, the UM change instruction program **1232** updates the migration-destination volume and the migration-destination storage apparatus in relation to the migration volume in the user-specified migration task management information **131** to the migration-destination volume and migration-destination storage apparatus, which conform to the migration policy of the target migration. For example, in a case where the migration policy is "same media type (migrate to accessible volume having same media type)", the UM change instruction program **1232** selects a logical volume, which is based on a storage device of the same type as the storage device constituting the basis of the migration-source volume and the storage apparatus comprising the relevant logical volume, and registers information regarding the selected migration-destination volume and migration-destination storage apparatus in the user-specified migration task management information **131**. Next, the UM change instruction program **1232** changes the action with respect to the target affected UM to "suspend" (Step S**511**). Specifically, the UM change instruction program **1232**, for example, stores data showing that the action with respect to the target affected UM is "suspend" in the memory **12**. Thereafter, the UM change instruction program **1232** ends the user-specified migration change instruction process.

Alternatively, in a case where the setting change with respect to the target affected UM is an action change from "suspend" to "resume" (Step S**502**: YES), the UM change instruction program **1232** determines whether or not the migration-source volume is not included in the stop-target DKC, and, in addition, the physical page of the migration-source volume is not included in the block-target RAID group (Step S**503**).

In a case where the result of the determination in Step S**503** is affirmative (Step S**503**: YES), the UM change instruction program **1232** references the information showing the contents of the setting change included in the parameter received in Step S**501**, and identifies the post-change migration-destination storage apparatus and migration-destination volume (Step S**504**).

Following S**504**, the UM change instruction program **1232** references the user-specified migration task management information **131** and determines whether or not the user-specified migration task for executing the target affected UM is the waiting-to-execute state, that is, whether or not the task status **1316** is configured to "waiting" (Step S**505**).

In a case where the user-specified migration task for executing the target affected UM is the waiting-to-execute state (Step S**505**: YES), the UM change instruction program **1232**, based on the user-specified migration task management information **131**, determines whether or not migration processing with respect to the change-target migration-source volume of the migration-destination volume received in S**504** has already been completed (Step S**506**).

In a case where the user-specified migration task for executing the target affected UM is not the waiting-to-execute state (Step S**505**: NO), or the migration processing has not been completed yet (Step S**506**: NO), the UM change instruction program **1232** changes the values of the migration-destination storage apparatus **1315** and the migration-destination volume **1314** of the target affected UM to the identifiers of the migration-destination storage apparatus and the migration-destination volume identified in Step S**505** in the user-specified migration task management information **131** (Step S**507**).

Thereafter, the UM change instruction program **1232** changes the action with respect to the target affected UM to "resume" (Step S**508**). Specifically, the UM change instruction program **1232**, for example, stores data showing that the action with respect to the target affected UM is "resume" in the memory **12**. Thereafter, the UM change instruction program **1232** ends the user-specified migration change instruction process.

In a case where the result of the determination in Step S**503** is negative (Step S**503**: NO), or a case where the migration processing has already been completed (Step S**506**: YES), the UM change instruction program **1232** notifies the administrator to the effect that the target affected UM is not a target for a setting change (Step S**512**), and ends the user-specified migration change instruction process.

FIG. **23** is a block diagram of an example of a user-specified migration action change screen related to the example 1.

The user-specified migration action change screen **53** is a screen for receiving an instruction for changing a setting (action change) with respect to an affected user-specified migration from the administrator. The management computer **1** transfers information showing the contents of the setting change inputted via the user-specified migration action change screen **53** to the UM change instruction program **1232** as a parameter.

The user-specified migration action change screen **53** comprises an area **531** for receiving a specification as to whether the action with respect to the affected user-specified migration is to be set to "suspend" or "resume". The area **531** comprises an area **532** for receiving a post-suspend migration policy specification with respect to suspending the migration (for example, an administrator desired selection from among multiple migration policy selections), and an area **533** for receiving a specification for a post-change migration-destination storage apparatus and migration-destination volume when the affected user-specified migration is to resume.

In a case where the user-specified migration task comprises multiple volume migrations (sub-tasks), the "post-suspend migration policy" related to the area **532** is a policy for migrating data inside the affected volume to another accessible area (volume) after migration suspends in a case where a portion of the volume migrations has already been completed (normal completion) when migration suspends, and, in addition, the migration-destination volume of the normal-completion volume migration is in an area in a stop/block-target DKC. As the "migration policy", for example, as disclosed in FIG. **23**, there is "ANY (Migrate to any accessible volume with same capacity)", "Same media type (migrate to accessible volume having same media type)", "High-performance media (migrate to volume having highest possible performance media type)", and "Low-performance media (migrate to volume having lowest possible performance media type)". Naturally, the migration policy is not limited to the policies mentioned above, and another policy can be used

as the migration policy either instead of or in addition to at least one of the above-mentioned migration policies.

The user-specified migration action change screen **53** makes it possible for the administrator to change an action with respect to an affected user-specified migration.

Then, in a case where the affected user-specified migration is to resume, the administrator can input information to the area **533** denoting the desired migration-destination storage apparatus and migration-destination volume. For example, the administrator, in a case where the affected user-specified migration is to resume, can change the migration-destination volume to a logical volume **264**, which will not be affected by the stopping of the storage apparatus **2** or the blocking of the storage area, that is, a logical volume **264**, which does not exist in the stop-target storage apparatus **2** in a case where the storage apparatus is to be stopped, and a logical volume **264**, which is not related to the block-target RAID group **262**, in a case where the storage area is to be blocked.

According to a screen configuration like that shown in FIG. **23**, a valid value is entered for only one item per UM in the columns "Policy selections for affected volume migration destination" and "New Migration Target" of the "Affected user-specified migration" **5221** of FIG. **20** in a user-specified migration setting change; other items are invalid values (n/a).

(5-3) Inter-Tier Page Migration Change Instruction Process

FIG. **24** is a flowchart of an inter-tier page migration change instruction process related to the example 1.

At the start of inter-tier page migration change instruction processing, the PM change instruction program **1233** receives a parameter comprising the identifier of an affected inter-tier page migration, which is targeted for a setting change (a post-suspend migration policy change) (hereinafter referred to as "target affected PM" in the explanation of FIG. **24**), and information showing the content of a setting change inputted by the administrator to the inter-tier page migration action change screen **54** (FIG. **25**) (Step S**601**). The information showing the contents of the setting change, for example, comprises information showing the post-suspend migration policy of the target affected PM.

The post-suspend migration policy of the affected inter-tier page migration here refers to a policy showing how data stored in a storage area, which has become inaccessible in a case where the storage apparatus **2** has been stopped or the storage area has been blocked, is to be migrated to an accessible area. In this example, as the post-suspend migration policy of the affected inter-tier page migration, for example, there is (a) a policy via which data may be migrated to any tier in the pool **265** where there is an accessible area, (b) a policy for migrating data as much as possible to an accessible area of a tier **2651** at the same level as the tier **2651** allocated when the inter-tier page migration is suspended, (c) a policy for migrating data to an accessible area of a tier **2651** at the highest possible level than the tier **2651** allocated when the inter-tier page migration is suspended, and (d) a policy for migrating data to an accessible area of a tier **2651** at the lowest possible level than the tier **2651** allocated when the inter-tier page migration is suspended. A policy other than the policies (a) through (d) may be used. For example, data showing the post-suspend migration policy for each affected inter-tier page migration is stored in the memory **12**. The initial value of the post-suspend migration policy for each affected inter-tier page migration is configured, for example, in the policy (b).

First, the PM change instruction program **1233** references information showing the contents of the setting change included in the parameter received in Step S**601**, and identifies the post-suspend migration policy of the target affected PM (Step S**602**).

Next, the PM change instruction program **1233** stores data showing that the post-suspend migration policy of the target affected PM is the policy identified in Step S**602**, for example, as an entry in information for managing the post-suspend migration policy of the target affected PM in the memory **12** (Step S**603**). Thereafter, the PM change instruction program **1233** ends the inter-tier page migration change instruction process.

FIG. **25** is a block diagram of an example of an inter-tier page migration action change screen related to the example 1.

The inter-tier page migration action change screen **54** is the screen for receiving an instruction from the administrator to change a setting (post-suspend migration policy change) with respect to an affected inter-tier page migration. The management computer **1** transfers information showing the contents of the setting change inputted via the inter-tier page migration action change screen **54** to the PM change instruction program **1233** as a parameter.

The inter-tier page migration action change screen **54** comprises an area **541** for receiving a specification for a post-suspend migration policy for the affected inter-tier page migration. For example, multiple migration policies (for example, the policies from (a) through (d) mentioned above) are selectably displayed in the area **541**.

(5-4) User-Specified Migration Suspend Instruction Process

FIG. **26** is a flowchart of a user-specified migration suspend instruction process related to the example 1.

The suspend instruction program **1234** executes the processing of Steps S**701** through S**706** for each affected user-specified migration regarded as a suspend target, that is, each affected user-specified migration for which the action is configured to "suspend". In the explanation of FIG. **26** below, the processing-target affected user-specified migration will be called "target affected UM".

The suspend instruction program **1234** references the user-specified migration task management information **131** and determines whether or not the user-specified migration task for executing the target affected UM is the waiting-to-execute state, that is, whether or not the task status **1316** is configured to "waiting" (Step S**702**).

In a case where the user-specified migration task for executing the target affected UM is the waiting-to-execute state (Step S**702**: YES), the suspend instruction program **1234** changes the value of the task status **1316** of the user-specified migration task for executing the target affected UM to "cancel" in the user-specified migration task management information **131** (Step S**703**). A user-specified migration task for which the task status **1316** is configured to "cancel" like this is not executed even when the execution start date/time has elapsed.

Alternatively, in a case where the user-specified migration task for executing the target affected UM is not the waiting-to-execute state, that is, a case in which this migration task is the executing state (Step S**702**: NO), the suspend instruction program **1234** suspends the user-specified migration task for executing the target affected UM (Step S**704**). At this time, in a case where the suspended task is a task for executing multiple user-specified migrations, and there exists among the multiple user-specified migrations a user-specified migration for which processing was already completed prior to task suspension, the suspend instruction program **1234** cancels the processing of the user-specified migration for which processing was completed prior to the suspension, that is, performs a rollback.

The user-specified migration rollback, for example, is performed in accordance with canceling the interchange of configuration control information between the migration-source

volume and the migration-destination volume, that is, by restoring the interchanged information to its original state. In a user-specified migration of this example, the data of the migration-source volume is unidirectionally replicated in the migration-destination volume, and the interchange of data between the migration-source volume and the migration-destination volume is not carried out. Therefore, the original data remains in the migration-source volume, and there is no need to cancel the data copy.

Thereafter, the suspend instruction program **1234**, based on the user-specified migration task management information **131**, determines whether or not a sub-task in which the migration-destination volume is a volume affected by the DKC stop/RAID group block, and, in addition, for which migration has already been completed exists among the portion of sub-tasks (volume migrations) included in the relevant task (Step S**705**). In a case where the result of the determination of Step S**705** is negative (Step S**705**: NO), the suspend instruction program **1234** changes the value of the task status **1316** of the user-specified migration for executing the target affected UM to "suspend partway through" in the user-specified migration task management information **131** (Step S**721**).

Alternatively, in a case where the result of the determination of Step S**705** is affirmative (Step S**705**: YES), the suspend instruction program **1234** identifies a sub-task in which the migration-destination volume is a volume affected by the DKC stop/RAID group block, and, in addition, for which migration has ended normally (Step S**706**). Then, Steps S**708** through S**719** are performed with respect to the migration-destination volume of each sub-task identified in Step S**706** (Steps S**707** and S**720**). That is, the suspend instruction program **1234** determines whether or not the migration policy is "same media type" (Step S**708**). In a case where the result of the determination of Step S**708** is affirmative (Step S**708**: YES), the suspend instruction program **1234** determines whether or not there is a free volume (free logical volume), which is accessible, and, in addition, is based on a storage device of the same media type as the storage device constituting the basis of the migration-source volume (Step S**709**).

In a case where the result of the determination of Step S**709** is affirmative (Step S**709**: YES), the suspend instruction program **1234** migrates the data from the migration-source volume to this free volume (Step S**710**).

In a case where the result of the determination of Step S**708** is negative (Step S**708**: NO), the suspend instruction program **1234** determines whether or not the migration policy is "high-performance media" (Step S**711**).

In a case where the result of the determination of Step S**711** is affirmative (Step S**711**: YES), the suspend instruction program **1234** determines whether or not there is a free volume, which is accessible, and, in addition, is based on a higher performance storage device than the storage device constituting the basis of the migration-source volume (Step S**712**).

In a case where the result of the determination of Step S**712** is affirmative (Step S**712**: YES), the suspend instruction program **1234** migrates the data from the migration-source volume to the free volume (S**713**).

In a case where the result of the determination of Step S**711** is negative (Step S**711**: NO), the suspend instruction program **1234** determines whether or not the migration policy is "low-performance media" (Step S**714**).

In a case where the result of the determination of Step S**714** is affirmative (Step S**714**: YES), the suspend instruction program **1234** determines whether or not there is a free volume, which is accessible, and, in addition, is based on a lower performance storage device than the storage device constituting the basis of the migration-source volume (Step S**715**).

In a case where the result of the determination of Step S**715** is affirmative (Step S**715**: YES), the suspend instruction program **1234** migrates the data from the migration-source volume to the free volume (S**716**).

In a case where the results of the determinations of Step S**709**, S**712**, S**714**, or S**715** are negative (Step S**709**, S**712**, S**714**, or S**715**: NO), the suspend instruction program **1234** determines whether or not there is an accessible volume (S**717**).

In a case where the result of the determination of Step S**717** is affirmative (Step S**717**: YES), the suspend instruction program **1234** migrates the data from the migration-source volume to the accessible free volume (S**719**).

In a case where the result of the determination of Step S**717** is negative (Step S**717**: NO), the suspend instruction program **1234** issues a notification (for example, a display) to the effect "data inside migration-source volume cannot be migrated after suspend" (S**718**).

After Steps S**708** through S**719** have been performed for the migration-destination volume of each sub-task identified in S**706** (Steps S**707** and S**720**), the above-mentioned Step S**721** is performed.

In the explanation of the embodiment, an accessible volume signifies a volume, which is not affected by the stopping of the storage apparatus or the blocking of a storage area (RAID group). That is, an accessible volume is a volume (a logical volume), which does not belong to a stop-target storage apparatus and is not comprised of a physical page belonging to a block-target RAID group. Whether or not the volume belongs to the relevant storage apparatus, and whether or not the volume comprises a physical page belonging to the relevant RAID group can be determined by referencing the logical volume management information and the physical page management information.

The suspend instruction program **1234** ends the user-specified migration suspend instruction process after ending the execution of the processing of Steps S**701** through S**722** for each affected user-specified migration regarded as a suspend target. In the above-described processing, any of S**708**, S**711**, and S**714** may be determined beforehand.

(5-5) Inter-Tier Page Migration Suspend Instruction Process

FIG. **27** is a flowchart of an inter-tier page migration suspend instruction process related to the example 1.

The suspend instruction program **1234** executes the processing of Steps S**801** through S**820** with respect to each affected inter-tier page migration for which the affected inter-tier page migration is regarded as a suspend target, that is, the action is configured to "suspend". Hereinafter, the processing-target affected inter-tier page migration will be called "target affected PM" in the explanation of FIG. **27**.

First, the suspend instruction program **1234** suspends the target affected PM (Step S**802**). Specifically, the suspend instruction program **1234** instructs the storage apparatus **2** in which the pool **265** (hereinafter referred to as "target affected pool") in which the target affected PM is performed exists to suspend the target affected PM. The storage apparatus **2**, which receives this instruction, suspends the target affected PM.

Next, the suspend instruction program **1234**, for example, references data showing the migration policy stored in the memory **12** and identifies the post-suspend migration policy of the target affected PM (Step S**803**).

Next, the suspend instruction program **1234** references the management-side logical volume management information **127**, the management-side virtual volume management information **128**, and the management-side pool management information **129**, and identifies a virtual segment **272** (first

virtual segment) (hereinafter referred to as "target virtual segment") to which an affected physical page (first physical page) in the target affected pool is allocated (Step S804). The affected physical page here is a segment 271, which will become inaccessible in a case where either the storage apparatus 2 is stopped or a storage area is closed, and is a physical page 271 included in a logical volume 264 existing in the stop-target storage apparatus 2 in a case where the storage apparatus 2 is stopped, and is a physical page 271 included in a logical volume 264 related to the block-target RAID group 262 in a case where a storage area is blocked.

In a case where the allocation source of the affected virtual segment (the physical page 271 allocated to the affected virtual segment) is left as the affected physical page as-is, that is, the data of the affected virtual segment is stored as-is in the affected physical page, and either the storage apparatus 2 is stopped or the storage area is blocked, the host 3 will not be able to access the data in the affected virtual segment. To avoid this, the suspend instruction program 1234 performs the processing of the following Steps S805 through S818 and migrates the data of the affected virtual segment from the affected physical page to a physical page 271, which is not an affected physical page, that is, to a physical page 271, which will be accessible even after the storage apparatus 2 is stopped or the storage area is blocked.

In the explanation of the embodiment, an accessible physical page signifies a physical page, which is not affected by the storage apparatus being stopped or the storage area (RAID group) being blocked. That is, an accessible physical page is a physical page, which does not belong to the stop-target storage apparatus, and is a physical page, which does not belong to the block-target RAID group. Whether or not a physical page belongs to the relevant storage apparatus, and whether or not a physical page belongs to the relevant RAID group can be determined by referencing the physical page management information.

The suspend instruction program 1234 executes the processing of Steps S805 through S818 for each affected virtual segment identified in Step S804. The processing-target affected virtual segment will be called "target affected virtual segment" hereinbelow.

The suspend instruction program 1234 determines whether or not the post-suspend migration policy of the target effected PM is policy (b), that is, the policy for migrating data as much as possible to an accessible area of a tier 2651 at the same level as the tier 2651 allocated when the inter-tier page migration is suspended (Step S806).

In a case where the post-suspend migration policy of the target affected PM is policy (b) (Step S806: YES), the suspend instruction program 1234 determines whether or not there exists an unallocated physical page 271 (hereinafter referred to as "same tier free area"), which is not an affected physical page and which belongs to the same tier 2651 as the affected physical page allocated to the target affected virtual segment (Step S809).

In a case where a same tier free area exists (Step S809: YES), the suspend instruction program 1234 instructs the storage apparatus 2 in which the target affected pool exists to migrate the data of the target affected virtual segment to the same tier free area, and to change the allocation source of the target affected virtual segment (the physical page 271 allocated to the target affected virtual segment) to the relevant same tier free area (Step S810). The storage apparatus 2, which receives this instruction, migrates the data of the target affected virtual segment to the same tier free area. Then, this instruction-receiving storage apparatus 2 changes the allocation source of the target affected virtual segment to the same tier free area to which the data has been migrated by changing the value of the physical page ID 2254 corresponding to the target affected virtual segment in the ST-side virtual volume management information 225 to the identifier of the same tier free area to which the data has been migrated.

In a case where the post-suspend migration policy of the target affected PM is not policy (b) (Step S806: NO), the suspend instruction program 1234 determines whether or not the post-suspend migration policy of the target affected PM is policy (c), that is, the policy for migrating data to an accessible area of a tier 2651 at the highest possible level than the tier 2651 allocated when the inter-tier page migration is suspended (Step S807).

In a case where the post-suspend migration policy of the target affected PM is policy (c) (Step S807: YES), the suspend instruction program 1234 determines whether or not there exists an unallocated segment 271 (hereinafter referred to as "higher-level tier free area"), which is not the affected segment and which belongs to a tier 2651 of a higher level than the tier 2651 to which the affected segment allocated to the target affected virtual segment belongs (Step S811).

In a case where a higher-level tier free area exists (Step S811: YES), the suspend instruction program 1234 instructs the storage apparatus 2 in which the target affected pool exists to migrate the data of the target affected virtual segment to the higher-level tier free area, and to change the allocation source of the target affected virtual segment to the relevant higher-level tier free area (Step S812). The storage apparatus 2, which receives this instruction, migrates the data of the target affected virtual segment to the higher-level tier free area. Then, this instruction-receiving storage apparatus 2 changes the allocation source of the target affected virtual segment to the higher-level tier free area to which the data has been migrated by changing the value of the physical page ID 2254 corresponding to the target affected virtual segment in the ST-side virtual volume management information 225 to the identifier of the higher-level tier free area to which the data has been migrated.

In a case where the post-suspend migration policy of the target affected PM is not policy (c) (Step S807: NO), the suspend instruction program 1234 determines whether or not the post-suspend migration policy of the target affected PM is policy (d), that is, the policy for migrating data to an accessible area of a tier 2651 at the lowest possible level than the tier 2651 allocated when the inter-tier page migration suspends (Step S808).

In a case where the post-suspend migration policy of the target affected PM is policy (d) (Step S808: YES), the suspend instruction program 1234 determines whether or not there exists an unallocated physical page 271 (hereinafter referred to as "lower-level tier free area"), which is not the affected physical page and which belongs to a tier 2651 of a lower level than the tier 2651 to which the affected physical page allocated to the target affected virtual segment belongs (Step S813).

In a case where a lower-level tier free area exists (Step S813: YES), the suspend instruction program 1234 instructs the storage apparatus 2 in which the target affected pool exists to migrate the data of the target affected virtual segment to the lower-level tier free area, and to change the allocation source of the target affected virtual segment to the relevant lower-level tier free area (Step S814). The storage apparatus 2, which receives this instruction, migrates the data of the target affected virtual segment to the lower-level tier free area. Then, this instruction-receiving storage apparatus 2 changes the allocation source of the target affected virtual segment to the lower-level tier free area to which the data has been

migrated by changing the value of the physical page ID **2254** corresponding to the target affected virtual segment in the ST-side virtual volume management information **225** to the identifier of the lower-level tier free area to which the data has been migrated.

In a case where the post-suspend migration policy of the target affected PM is not policy (d) (Step S**808**: NO), a case where a same tier free area does not exist (Step S**809**: NO), a case where a higher-level tier free area does not exist (Step S**811**: NO), or a case where a lower-level tier free area does not exist (Step S**813**: NO), the suspend instruction program **1234** determines whether or not an unallocated physical page **271**, which is not an affected physical page (hereinafter referred to as "free accessible area") exists in the target affected pool (Step S**815**).

In a case where a free accessible area exists (Step S**815**: YES), the suspend instruction program **1234** instructs the storage apparatus **2** in which the target affected pool exists to migrate the data of the target affected virtual segment to the free accessible area, and to change the allocation source of the target affected virtual segment to the relevant free accessible area (Step S**816**). The storage apparatus **2**, which receives this instruction, migrates the data of the target affected virtual segment to the free accessible area. Then, this instruction-receiving storage apparatus **2** changes the allocation source of the target affected virtual segment to the free accessible area to which the data has been migrated by changing the value of the physical page ID **2254** corresponding to the target affected virtual segment in the ST-side virtual volume management information **225** to the identifier of the free accessible area to which the data has been migrated.

Alternatively, in a case where a free accessible area does not exist (Step S**815**: NO), the suspend instruction program **1234** notifies the administrator to the effect that a free accessible area does not exist in the target affected pool. Then, the suspend instruction program **1234** instructs the storage apparatus **2** in which the target affected pool exists to add an unused logical volume **264** to the target affected pool, to migrate the data of the target affected virtual segment to a physical page **271** (hereinafter referred to as "added segment") included in the added logical volume **264**, and to change the allocation source of the target affected virtual segment to the relevant added segment (Step S**817**). The storage apparatus **2**, which receives this instruction, migrates the data of the target affected virtual segment to the added segment. Then, this instruction-receiving storage apparatus **2** changes the allocation source of the target affected virtual segment to the added segment to which the data has been migrated by changing the value of the physical page ID **2254** corresponding to the target affected virtual segment in the ST-side virtual volume management information **225** to the identifier of the added segment to which the data has been migrated. The logical volume **264**, which has been added to the target affected pool, is a logical volume **264**, which is not affected by either the storage apparatus **2** being stopped or the storage area being blocked, that is, a logical volume **264**, which does not belong to the stop-target storage apparatus **2** in a case where the storage apparatus **2** is stopped, and a logical volume **264**, which is not related to the block-target RAID group **262** in a case where the storage area is blocked.

The suspend instruction program **1234**, after ending the execution of the processing of Steps S**805** through S**818** for all the target virtual segments identified in Step S**804**, instructs the storage apparatus **2** in which the target affected pool exists to change the value of the inter-tier page migration **2264** of the target affected pool in the ST-side pool management information **226** to "OFF" (Step S**819**). The storage apparatus **2**, which receives this instruction, changes the value of the inter-tier page migration **2264** of the target affected pool in the ST-side pool management information **226** to "OFF". The management-side pool management information **129** is also updated to the same data as that of the ST-side pool management information **226**.

The suspend instruction program **1234** ends the inter-tier page migration suspend instruction process after ending the execution of the processing of Steps S**801** through S**820** for all the affected inter-tier page migrations regarded as suspend targets.

After migrating the data of the target affected virtual segment and changing the allocation source of the target affected virtual segment in Steps S**810**, S**812**, S**814**, S**816**, and S**817**, the storage apparatus **2**, which received the instruction, in the ST-side physical page management information **223**, changes the allocation status **2234** of the physical page **271** allocated up until then to the target affected virtual segment to "unallocated", and changes the allocation status **2234** of the physical page **271** allocated anew to the target affected virtual segment to "allocated". The management-side virtual volume management information **128** and the management-side physical page management information **126** are also updated to the same data as the ST-side virtual volume management information **225** and the ST-side physical page management information **223**.

(5-6) User-Specified Migration Required Time Computation Process

FIG. **28** is a flowchart of a user-specified migration required time computation process related to the example 1.

The UM required time computation program **1235** receives a parameter comprising the identifier of a user-specified migration task (hereinafter referred to as "computation target task") constituting the target of computation processing when the user-specified migration required time computation process starts. The UM required time computation program **1235** reads the user-specified migration execution history information **132** (Step S**901**).

Next, the UM required time computation program **1235** computes the total value of the amount of data to be migrated in accordance with the user-specified migration (hereinafter referred to as "computation target UM"), which the computation target task executes (Step S**902**).

Thereafter, the UM required time computation program **1235** computes an average migration time per unit of amount of data of the user-specified migration (Step S**903**). The average migration time per unit of amount of data of the user-specified migration, for example, is obtained by dividing the value of the total value of execution time periods **1322** in the user-specified migration execution history information **132** by the value of the total value of migration data amounts **1323**.

Thereafter, the UM required time computation program **1235** computes the time expected to be needed for the computation-target UM, and computes the expected completion date/time of the computation-target task (Step S**904**). The time expected to be needed for the computation-target UM, for example, is obtained by multiplying the average migration time per unit of amount of data of the user-specified migration computed in Step S**903** by the total value of the amount of data computed in Step S**902**. The expected completion date/time of the computation-target task is obtained by adding the expected time needed for the computation-target UM to the task execution start date/time.

(5-7) Inter-Tier Page Migration Required Time Computation Process

An inter-tier page migration required time computation process related to the example 1 will be explained hereinbelow.

The PM required time computation program **1236** receives a parameter comprising the identifier of an inter-tier page migration (hereinafter referred to as "computation target PM") constituting the target of computation processing when the inter-tier page migration required time computation process starts. The PM required time computation program **1236** reads the inter-tier page migration execution history information **133** (Step S**2501**).

Next, the PM required time computation program **1236** computes the used capacity of the pool **265**, in which the computation-target PM is performed (Step S**2502**).

Thereafter, the PM required time computation program **1236** computes an average migration time per unit of amount of data of the inter-tier page migration (Step S**2503**). The average migration time per unit of amount of data of the inter-tier page migration, for example, is obtained by dividing the value of the total value of execution time periods **1322** in the inter-tier page migration execution history information **133** by the value of the total value of migration data amounts **1323**.

Thereafter, the PM required time computation program **1236** computes the time expected to be needed for the computation-target PM, and computes the expected completion date/time of the computation-target PM (Step S**2504**). The time expected to be needed for the computation-target PM, for example, is obtained by multiplying the average migration time per unit of amount of data of the inter-tier page migration computed in Step S**2503** by the used capacity computed in Step S**2502**. The expected completion date/time of the computation-target PM, for example, is obtained by adding the expected time needed for the computation-target PM to the execution start date/time of the computation-target PM.

(6) Performance Information Acquisition Process

FIG. **29** is a flowchart of a performance information acquisition process related to the example 1.

First, the performance information acquisition program **1211** resets the value of the IOPS **1286** and the value of the reallocation destination determination result **1287** of the management-side virtual volume management information **128** (Step S**1001**).

The performance information acquisition program **1211** executes the processing of Steps S**1002** through S**1006** for each virtual segment **272** of each virtual volume **266**. The processing-target virtual segment **272** will be called "target virtual segment" hereinbelow.

The configuration management program **121** acquires the value of the number of accesses **2255** and the value of the monitoring period **2256** corresponding to the target virtual segment from the ST-side virtual volume management information **225** (Step S**1003**). For example, the configuration management program **121** sends a request to the storage apparatus **2** requesting information on the number of accesses corresponding to the target virtual segment. This request comprises the identifier of the target virtual segment.

The performance information acquisition program **1211** computes an average IOPS value for the target virtual segment based on the number of accesses and monitoring period of the target virtual segment (Step S**1004**). The performance information acquisition program **1211** stores the computed average IOPS value in the IOPS **1286** corresponding to the target virtual segment in the management-side virtual volume management information **128** (Step S**1005**).

The performance information acquisition program **1211** ends the performance information acquisition process after ending the processing of Steps S**1002** through S**1006** for each virtual segment **272** of each virtual volume **266**.

(7) Reallocation Process

FIG. **30** is a flowchart of a reallocation process related to the example 1.

First, the reallocation program **1212** references the management-side virtual volume management information **128** and the management-side pool management information **129**, and identifies a virtual volume **266** (hereinafter "target virtual volume") constituting the target of a reallocation process. The target virtual volume here is a virtual volume **266**, which is associated with a pool **265** for which an inter-tier page migration is valid, that is, a virtual volume **266** to which is allocated a physical page **271** included in a pool **265** for which the inter-tier page migration **2264** of the management-side pool management information **129** is configured to "ON".

The reallocation program **1212** executes the processing of Steps S**1101** through S**1103** for each virtual segment **272** of the target virtual volume. The processing-target virtual segment **272** will be called "target virtual segment" hereinbelow.

The reallocation program **1212** identifies a tier **2651** to be allocated to the target virtual segment (Step S**1102**). Specifically, the reallocation program **1212** acquires the average IOPS value for the target virtual segment from the management-side virtual volume management information **128**, references the allocation condition **1244** in the tier management information **124**, and identifies the tier **2651** having the allocation condition, which comprises the acquired average IOPS value within its range. This identified tier **2651** is the tier **2651** to be allocated to the target virtual segment. The reallocation program **1212** stores the identifier of the identified tier **2651** in the reallocation destination determination result **1287** corresponding to the target virtual segment in the management-side virtual volume management information **128**. The identified tier **2651** may be the same tier **2651** to which the physical page **271** allocated to the target virtual segment belongs, or may be a different tier **2651**.

The reallocation program **1212** stores the start date/time of the reallocation process, for example, in the memory **12** after ending the execution of the processing of Steps S**1101** through S**1103** for each virtual segment **272** in the target virtual volume. The reallocation program **1212**, for example, initializes (clears to zero) the value of a variable "amount of migrated data" stored in the memory **12** (Step S**1104**). The start date/time of the reallocation process is used for computing the time required to migrate data in the reallocation process, and the variable "amount of migrated data" is used for computing the total value of the amounts of data migrated in accordance with the reallocation process.

The reallocation program **1212** executes the processing of Steps S**1105** through S**1113** in descending order from the highest average IOPS value for each virtual segment **272** in the target virtual volume. The processing-target virtual segment **272** will be called "target virtual segment" hereinbelow.

The reallocation program **1212** determines whether or not the tier **2651** (hereinafter referred to as "current tier") to which the physical page **271** allocated to the target virtual segment belongs matches the tier **2651** (hereinafter referred to as "reallocation-destination tier") shown by the reallocation destination determination result **1287** corresponding to the target virtual segment in the management-side virtual volume management information **128** (Step S**1106**).

In a case where the current tier and the reallocation-destination tier are a match (Step S**1106**: YES), it is not necessary

to migrate the data of the target virtual segment. The reallocation program **1212** advances the processing to Step **S1112**.

Alternatively, in a case where the current tier and the reallocation-destination tier do not match (Step **S1106**: NO), the reallocation program **1212** references the management-side physical page management information **126**, and determines whether or not an unallocated physical page **271** exists in the reallocation-destination tier (Step **S1107**).

In a case where an unallocated physical page **271** exists in the reallocation-destination tier (Step **S1107**: YES), the reallocation program **1212** instructs the storage apparatus **2**, which provides the target virtual volume, to migrate the data of the target virtual segment to the unallocated physical page **271** (hereinafter referred to as "reallocation-destination free area") in the reallocation-destination tier, and to change the allocation source of the target virtual segment to the relevant reallocation-destination free area (Step **S1108**). The storage apparatus **2**, which receives this instruction, migrates the data of the target virtual segment to the reallocation-destination free area. Then, this instruction-receiving storage apparatus **2** changes the allocation source of the target virtual segment to the reallocation-destination free area to which the data has been migrated by changing the value of the physical page ID **2254** corresponding to the target virtual segment in the ST-side virtual volume management information **225** to the identifier of the reallocation-destination free area to which the data has been migrated. Also, this instruction-receiving storage apparatus **2**, in the ST-side physical page management information **223**, changes the allocation status **2234** of the physical page **271** allocated up until then to the target virtual segment to "unallocated", and changes the allocation status **2234** of the physical page **271** allocated anew to the target virtual segment to "allocated". The management-side virtual volume Management information **128** and the management-side physical page management information **126** are also updated to the same data as the ST-side virtual volume management information **225** and the ST-side physical page management information **223**.

The reallocation program **1212** adds the amount of data migrated in Step **S1108** to the variable "amount of migrated data". Thereafter, the reallocation program **1212** advances the processing to Step **S1112**.

Alternatively, in a case where an unallocated physical page **271** does not exist in the reallocation-destination tier (Step **S1107**: NO), the reallocation program **1212** determines whether or not there exists in the reallocation-destination tier a physical page **271** (hereinafter referred to as "interchangeable area") capable of interchanging data with the physical page **271** allocated to the target virtual segment (Step **S1109**).

In a case where an interchangeable area exists (Step **S1109**: YES), the reallocation program **1212** instructs the storage apparatus **2**, which provides the target virtual volume, to interchange data between the segment **271** allocated to the target virtual segment and the interchangeable area (Step **S1110**). The storage apparatus **2**, which receives this instruction, for example, interchanges the data by performing the following processing. The cache memory area in the following processing may be an unallocated physical page **271** of the storage apparatus **2**. The target virtual segment will be written as "virtual segment **1**" here, and the physical page **271** allocated to the target virtual segment will be written as "physical page **1**". In addition, the virtual segment to which the interchangeable area is allocated will be written as "virtual segment **2**", and the interchangeable area will be written as "physical page **2**".

Process 1: The storage apparatus **2** writes data in the physical page **1** to a cache memory area.

Process 2: The storage apparatus **2** writes data in the physical page **2** to the cache memory area.

Process 3: The storage apparatus **2** writes the data of the physical page **1** from the cache memory area to the physical page **2**.

Process 4: The storage apparatus **2** writes the data of the physical page **2** from the cache memory area to the physical page **1**.

Process 5: The storage apparatus **2** stores the identifier of the physical page **2** in the physical page ID **2254** corresponding to the virtual segment **1** in the ST-side virtual volume management information **225**.

Process 6: The storage apparatus **2** stores the identifier of the physical page **1** in the physical page ID **2254** corresponding to the virtual segment **2** in the ST-side virtual volume management information **225**.

Furthermore, the same data as that of the ST-side virtual volume management information **225** is also updated in the management-side virtual volume management information **128**.

The reallocation program **1212** adds the amount of data interchanged in Step **S1110** to the variable "amount of migrated data". Thereafter, the reallocation program **1212** advances the processing to Step **S1112**.

Alternatively, in a case where an interchangeable area does not exist (Step **S1109**: NO), the reallocation program **1212** instructs the storage apparatus **2**, which provides the target virtual volume, to migrate the data of the target virtual segment to an unallocated physical page **271** (hereinafter referred to as "similar-performance free area") in a tier **2651** having performance most closely approximating that of the reallocation-destination tier, and to change the allocation source of the target virtual segment to the relevant similar-performance free area (Step **S1111**). The storage apparatus **2**, which receives this instruction, migrates the data of the target virtual segment to the similar-performance free area. Then, this instruction-receiving storage apparatus **2** changes the allocation source of the target virtual segment to the similar-performance free area to which the data has been migrated by changing the value of the physical page ID **2254** corresponding to the target virtual segment in the ST-side virtual volume management information **225** to the identifier of the similar-performance free area to which the data has been migrated. In addition, this instruction-receiving storage apparatus **2**, in the ST-side physical page management information **223**, changes the allocation status **2234** of the physical page **271** allocated up until then to the target virtual segment to "unallocated", and changes the allocation status **2234** of the physical page **271** allocated anew to the target virtual segment to "allocated". The management-side virtual volume management information **128** and the management-side physical page management information **126** are also updated to the same data as the ST-side virtual volume management information **225** and the ST-side physical page management information **223**.

The reallocation program **1212** adds the amount of data migrated in Step **S1111** to the variable "amount of migrated data". Thereafter, the reallocation program **1212** advances the processing to Step **S1112**.

In Step **S1112**, the reallocation program **1212** determines whether or not an end-program instruction has been received (Step **S1112**).

In a case where an end-program instruction has been received (Step **S1112**: YES), the reallocation program **1212** ends the reallocation process.

Alternatively, in a case where an end-program instruction has not been received (Step S1112: NO), the reallocation program **1212** continues the processing of Steps S1105 through S1113.

The reallocation program **1212**, after ending the execution of the processing of Steps S1105 through S1113 for all the virtual segments **272** in the target virtual volume, reflects the actual value of the reallocation processing in the inter-tier page migration execution history information **133** (Step S1114). Specifically, the reallocation program **1212** adds the time required for reallocation processing to the total value of execution time periods **1322**, and adds the total value of the amount of data migrated in accordance with the reallocation processing, that is, the value of the variable "amount of migrated data" to the total value of migration data amounts **1323**. The time required for reallocation processing, for example, is obtained by subtracting the reallocation process start date/time stored in Step S1104 from the reallocation process completion date/time (the current date/time). Thereafter, the reallocation program **1212** ends the reallocation process.

According to the example 1, the management computer **1** identifies an affected migration prior to either stopping the storage apparatus **2** or blocking the storage area, presents the administrator with information related to the identified affected migration, receives an action change with respect to the identified affected migration, and suspends the affected migration, which is regarded as the suspend target.

The management computer **1**, when suspending the affected migration (an affected user-specified migration and an affected inter-tier page migration), migrates data, which is in an area (either the migration-source volume or physical page **271** (affected physical page)), which will become inaccessible in a case where either the storage apparatus **2** is stopped or the storage area is blocked, to an area accessible by the host **3** (either a free volume or physical page **271**) subsequent to either stopping the storage apparatus **2** or blocking the storage area. In accordance with this, the administrator no longer needs to identify an area, which will become inaccessible subsequent to suspending the affected migration, and perform a data migration, lessening the burden on the administrator.

According to this example, the same effects can be achieved from the aspect of being able to lessen the burden on the administrator even in the case of an in-pool page migration in a pool in which affected migrations are not hierarchized.

Example 2

In an example 2, in addition to the post-suspend migration policy change, an action change is also possible as a setting change with respect to an affected inter-tier page migration. As actions with respect to an affected inter-tier page migration, there is "suspend", which suspends the affected inter-tier page migration, and "degenerate and resume", which resumes the affected inter-tier page migration by avoiding the affected physical page, that is, by using a physical page **271** in the pool **265**, which is not an affected physical page.

The configuration of the computer system related to the example 2 is substantially the same as the configuration of the computer system related to the example 1 with the exception of the management-side pool management information **129** stored in the management computer **1**.

Management-side pool management information related to the example 2 will be explained hereinbelow.

The management-side pool management information **129** related to the example 2 comprises the information items change mode **1291** and inaccessible pool-configured volume **1292** in addition to the respective information items comprising the management-side pool management information **129** related to the example 1. In a case where an inter-tier page migration to be performed in the pool **265** has been identified as an affected inter-tier page migration, data showing an action with respect to this migration, that is, either "suspend" or "degenerate and resume", is stored in the change mode **1291**. From among the logical volumes **264** comprising the pool **265**, the identifier of the logical volume **264**, which is affected by either the stopping of the storage apparatus **2** or the blocking of the storage area, is stored in the inaccessible pool-configured volume **1292**. Here, the logical volume **264**, which is affected by either the stopping of the storage apparatus **2** or the blocking of the storage area refers to either a logical volume **264**, which exists in the stop-target storage apparatus **2**, or a logical volume **264**, which is related to the block-target RAID group **262**. For example, the PM change instruction program **1233** identifies a logical volume **264**, which is affected by either the stopping of the storage apparatus **2** or the blocking of the storage area from among the logical volumes **264** comprising the pool **265**, and stores the identifier of this identified logical volume **264** in the inaccessible pool-configured volume **1292**.

The operation of the management computer **1** related to the example 2 will be explained below with respect to the differences with the example 1. Otherwise, the operation of the storage apparatus **2** related to the example 2 is substantially the same as the operation of the storage apparatus **2** related to the example 1.

FIG. **31** is a flowchart of an inter-tier page migration change instruction process related to the example 2.

In this drawing, the same reference signs are assigned to processes, which are substantially the same as those of the inter-tier page migration change instruction process (FIG. **24**) related to the example 1.

At the start of an inter-tier page migration change instruction process, the PM change instruction program **1233** receives a parameter, which comprises the identifier of an affected inter-tier page migration targeted for a setting change (hereinafter referred to as "target affected PM" in the explanation of FIG. **31**) and information showing the contents of a setting change inputted by the administrator in the inter-tier page migration action change screen **54** (Step S601).

The inter-tier page migration action change screen **54** related to the example 2 comprises an area for receiving a specification as to whether the action with respect to the affected inter-tier page migration is "suspend" or "degenerate and resume" in addition to the area **541** for receiving a post-suspend migration policy specification for the affected inter-tier page migration. Therefore, the information showing the contents of the setting change in Step S1201 comprises information showing the post-suspend migration policy of the target affected PM, and data showing the action with respect to the target affected PM.

The PM change instruction program **1233** determines whether or not the setting change with respect to the target affected PM is an action change from "suspend" to "degenerate and resume" (Step S1201).

In a case where the setting change with respect to the target affected PM is an action change from "suspend" to "degenerate and resume" (Step S1201: YES), the PM change instruction program **1233** changes the action with respect to the target affected PM to "degenerate and resume" (Step S1202). Specifically, the PM change instruction program **1233** stores

data showing "degenerate and resume" in the change mode **1291** of the management-side pool management information **129** for the pool **265** in which the target affected PM is performed. Thereafter, the PM change instruction program **1233** ends the inter-tier page migration change instruction process.

Alternatively, in a case where the setting change with respect to the target affected PM is not an action change from "suspend" to "degenerate and resume" (Step S**1201**: NO), the PM change instruction program **1233** performs the same processing as Steps S**602** and S**603** of FIG. **24**. Thereafter, the PM change instruction program **1233** ends the inter-tier page migration change instruction process.

In the example 2, the stop program **123** does not perform the inter-tier page migration suspend instruction process shown in FIG. **27** for an affected inter-tier page migration regarded as a resumption target, that is, an affected inter-tier page migration for which the action is configured to "degenerate and resume", and allows this affected inter-tier page migration to remain valid as-is. That is, the affected inter-tier page migration regarded as being targeted for resumption (reallocation process) is performed on either a regular or irregular basis. The suspend program **123** may also performs the processing of Steps S**804** through S**818** in the inter-tier page migration suspend instruction process with respect to the affected inter-tier page migration regarded to be targeted for resumption, and may migrate the data of the affected virtual segment from the affected physical page to the physical page **271**, which is not an affected physical page, that is, to a physical page **271**, which is also accessible subsequent to either stopping the storage apparatus **2** or blocking the storage area.

The reallocation process related to the example 2 will be explained hereinbelow with respect to the differences with the example 1 by referring to the reallocation process shown in FIG. **30** related to the example 1.

A virtual volume (target virtual volume), which is the target of the reallocation process related to the example 2, is a virtual volume **266** associated with a pool **265** in which the inter-tier page migration is valid, and, in addition, the action with respect to the inter-tier page migration is configured to "degenerate and resume", that is, a pool **265** for which "ON" is configured in the inter-tier page migration **2264** of the management-side pool management information **129**, and, in addition, "degenerate and resume" is configured in the change mode **1291**.

In the example 2, the reallocation program **1212** in Step S**1106** determines whether or not the tier **2651** (current tier) in which the physical page **271** allocated to the target virtual segment is not an affected physical page, and, in addition, to which the physical page **271** allocated to the target virtual segment belongs, matches the tier **2651** (reallocation-destination tier) shown by the reallocation-destination determination result **1287** corresponding to the target virtual segment in the management-side virtual volume management information **128**.

In the example 2, the reallocation program **1212** in Step S**1107** references the management-side physical page management information **126**, and determines whether or not there exists an unallocated physical page **271**, which belongs to the reallocation-destination tier and which is not an affected physical page (hereinafter referred to as "reallocation-destination accessible area").

In the example 2, the reallocation program **1212** in Step S**1108** instructs the storage apparatus **2**, which provides the target virtual volume, to migrate data of the target virtual segment to the reallocation-destination accessible area, and to change the allocation source of the target virtual segment to the relevant reallocation-destination accessible area. The reallocation program **1212** adds the amount of data migrated in Step S**1108** to the variable "amount of migrated data".

In the example 2, the reallocation program **1212** in Step S**1109** determines whether or not a physical page **271**, which is capable of interchanging data with the physical page **271** allocated to the target virtual segment and which is not an affected physical page (hereinafter referred to as "accessible interchange area"), exists in the reallocation-destination tier.

In the example 2, the reallocation program **1212** in Step S**1110** instructs the storage apparatus **2**, which provides the target virtual volume, to perform a data interchange between the physical page **271** allocated to the target virtual segment and the accessible interchange area. The reallocation program **1212** also adds the amount of data interchanged in Step S**1110** to the variable "amount of migrated data".

In the example 2, the reallocation program **1212** in Step S**1111** instructs the storage apparatus **2**, which provides the target virtual volume, to migrate data of the target virtual segment to an unallocated physical page **271**, which belongs to a tier **2651** most closely approximating the performance of the reallocation-destination tier and which is not an affected physical page (hereinafter referred to as "similar-performance accessible area"), and to change the allocation source of the target virtual segment to the relevant similar-performance accessible area. The reallocation program **1212** also adds the amount of data migrated in Step S**1111** to the variable "amount of migrated data".

In the reallocation process related to the example 2, the determination of Step S**1112** is not performed.

According to the example 2, it is possible to resume an affected inter-tier page migration by using a physical page **271**, which is accessible physical page **271** from the host **3** (not using an affected physical page) subsequent to either the storage apparatus **2** being stopped or the storage area being blocked. This makes it possible to either stop the storage apparatus **2** or block the storage area without an administrator setting or selection related to how to suspend the affected inter-tier page migration. Since an inter-tier page migration can be resumed subsequent to the storage apparatus **2** having been stopped or the storage area having been blocked, the data of the virtual segment **272** can be allocated to an accessible physical page **271** in an appropriate storage tier **2651** based on the host **3** access frequency with respect to this virtual segment **272** even after the storage apparatus **2** has been stopped or the storage area has been blocked. Performance-wise, this makes it possible to enhance the utilization efficiency of a storage area in the storage apparatus **2**.

In addition, according to the example 2, for example, in a pool **265** comprising a high-performance logical volume **264** of the internal storage apparatus and a low-performance logical volume **264** of an external storage apparatus, it is necessary to resume an affected inter-tier page migration in order to satisfy the host **3** application performance condition (SLA/SLO), and, in addition, in a case where the affect on the operation of the host **3** application in accordance with stopping the external storage apparatus for maintenance purposes or the like is trifling due to the fact that the capacity of the logical volume **264** allocated from the external storage apparatus is small, it is possible to stop the external storage apparatus without suspending the affected inter-tier page migration, and, in addition, without the administrator having to take the trouble to migrate data, which had been migrated to a physical page **271** in the stop-target storage apparatus **2**, to an accessible physical page **271**.

Example 3

In an example 3, the administrator is presented with information showing the affect on the host **3** from the standpoint of performance in a case where an affected inter-tier page migration was suspended, and information showing the affect from the standpoint of the capacity of the pool **265** (hereinafter referred to as "affected pool"), which is performing the relevant affected inter-tier page migration, with respect to the relevant affected inter-tier page migration identified using the affected migration identification process shown in FIG. **21** of the example 1. As the information showing the affect from the standpoint of performance here, for example, there is a by-tier allocation rate computed for each host **3**, which is accessing the virtual volume **266** associated with the affected pool. The by-tier allocation rate refers to the percentage by tier **2651** of physical pages **271** (for example, the number of physical pages **271** and the capacity of the physical pages **271**) allocated to the virtual volume **266** accessed by a target host **3**. In this example, the by-tier allocation rate is a percentage of the total capacity by tier **2651** of the physical pages **271** allocated to the virtual volume **266** accessed by the target host **3** with respect to the total capacity of all the physical pages **271** allocated to the virtual volume **266** accessed by the target host **3**. Also, as the information showing the affect from the standpoint of the capacity, for example, there is pool usage, which is the usage of the physical page **271** in the pool **265**.

The configuration of the computer system related to the example 3 is substantially the same as the configuration of the computer system related to the example 1 with the exception of the suspend program **123**, the management-side physical page management information **126**, and the management-side virtual volume management information **128** stored by the management computer **1**.

The suspend program **123** related to the example 3 executes a tier allocation status prediction process, which will be explained further below, performs a simulation with respect to how data stored in an affected physical page is to be migrated in a case where an affected inter-tier page migration has been suspended, and computes the by-tier allocation rate based on the result of the simulation.

The suspend program **123** related to the example 3 further comprises a pool usage computation program **1237**. The pool usage computation program **1237** computes for an affected pool a pool usage (hereinafter referred to as "pool usage prior to either stop or block") prior to either the storage apparatus **2** being stopped or the storage area being blocked, and the pool usage (hereinafter referred to as "pool usage after either stop or block") after either the storage apparatus **2** has been stopped or the storage area has been blocked.

Management-side physical page management information related to the example 3 will be explained hereinbelow.

The management-side physical page management information **126** related to the example 3 comprises the information item allocation status simulation **1262** in addition to the respective information items in the management-side physical page management information **126** related to the example 1. The allocation status simulation **1262** is used for storing a simulation result related to the allocation status of a physical page **271** in the tier allocation status prediction process.

The management-side virtual volume management information related to the example 3 will be explained hereinbelow.

The management-side virtual volume management information **128** related to the example 3 comprises the information item reallocation-destination simulation determination result **1288** in addition to the respective information items in the management-side virtual volume management information **128** related to the example 1. The reallocation-destination simulation determination result **1288** is used for storing a simulation result related to a migration-destination tier **2651** for data in a virtual segment **272** to which an affected physical page is allocated in the tier allocation status prediction process.

The operation of the management computer **1** related to the example 3 will be explained hereinbelow with respect to the differences with the example 1. Otherwise, the operation of the storage apparatus **2** related to the example 3 is substantially the same as the operation of the storage apparatus **2** related to the example 1.

FIG. **32** is a flowchart of a pool usage computation process related to the example 3.

The pool usage computation program **1237**, at the start of the execution of the pool usage computation process, receives a parameter, which comprises the identifier of a pool **265** (hereinafter referred to as "computation-target pool"), which is the target of the computation process, and information showing either a stop-target storage apparatus **2** or a block-target RAID group **262** specified by the administrator (Step S**1301**). Normally, the computation-target pool is the affected pool.

Next, the pool usage computation program **1237** computes the total capacity (A) of a physical page **271** in the computation-target pool (Step S**1302**).

Next, the pool usage computation program **1237** computes the total capacity (B) of a physical page **271** in the computation-target pool, which has been allocated to a virtual volume **266** (Step S**1303**).

Thereafter, the pool usage computation program **1237** computes the pool usage prior to either stop or block for the computation-target pool (Step S**1304**). The pool usage prior to either stop or block for the computation-target pool, for example, is computed in accordance with the formula "((B)/(A))×100 (unit: %)".

Thereafter, the pool usage computation program **1237** computes the total capacity (C) of a physical page **271**, which is not an affected physical page, in the computation-target pool (Step S**1305**).

Thereafter, the pool usage computation program **1237** computes the pool usage after either stop or block for the computation-target pool (Step S**1306**). The pool usage after either stop or block for the computation-target pool, for example, is computed in accordance with the formula "((B)/(C))×100 (unit: %)". Thereafter, the pool usage computation program **1237** ends the pool usage computation process.

The pool usage (pool usage prior to either stop or block and pool usage after either stop or block) computed in accordance with the pool usage computation process, for example, is displayed in the migration suspend screen **52** (FIG. **20**). For example, the management computer **1** performs the pool usage computation process for each affected inter-tier page migration, computes the pool usage for the pool **265** in which each affected inter-tier page migration is performed, and displays the computed pool usage in the area **5222** of the migration suspend screen **52**.

FIG. **33** is a block diagram of an example of an inter-tier page migration action change screen related to the example 3.

An area **542** for displaying the by-tier allocation rate computed for each host **3**, which accesses the virtual volume **266** associated with the affected pool, is included in the area **541** of the inter-tier page migration change screen **54** related to the example 3.

When a post-suspend migration policy for an affected inter-tier page migration is selected in the inter-tier page

migration change screen **54** related to the example 3, the storage program **123** executes the tier allocation status prediction process, and computes the by-tier allocation rate in a case where data stored in an affected segment has been migrated based on the selected migration policy. Then, the suspend program **123** displays the computer by-tier allocation rate in the area **542**.

In the example of the drawing, the by-tier allocation rate for tier **1**, which is related to host "HOST **1**", is 5%, the by-tier allocation rate for tier **2** is 32.5%, and the by-tier allocation rate for tier **3** is 62.5%. The by-tier allocation rate for tier **1** is computed in accordance with the formula "(Total capacity of physical page **271** belonging to tier **1**, which is allocated to virtual volume **266** accessed by Host "HOST **1**" (50 GB))/(total capacity of all physical pages **271** allocated to virtual volume **266** accessed by "HOST **1**" (1000 GB))×100". The by-tier allocation rate for tier **2** is computed in accordance with the formula "(Total capacity of physical page **271** belonging to tier **2**, which is allocated to virtual volume **266** accessed by Host "HOST **1**" (325 GB))/(total capacity of all physical pages **271** allocated to virtual volume **266** accessed by "HOST **1**" (1000 GB))×100". The by-tier allocation rate for tier **3** is computed in accordance with the formula "(Total capacity of physical page **271** belonging to tier **3**, which is allocated to virtual volume **266** accessed by Host "HOST **1**" (625 GB))/(total capacity of all physical pages **271** allocated to virtual volume **266** accessed by "HOST **1**" (1000 GB))×100".

Thus, the displaying of the by-tier allocation rate makes it possible for the administrator, for example, to determine whether or not enough high-performance storage tiers (SSD and the like) are allocated with respect to a host **3** application for which there exists a performance request (SLO).

A tier allocation status prediction process related to the example 3 will be explained hereinbelow.

First, the suspend program **123** stores the identifier of the tier **2651** to which the physical page **271** currently allocated to the corresponding virtual segment **272** belongs in the reallocation-destination simulation determination result **1288** for each virtual segment **272** in the management-side virtual volume management information **128** (Step S**2601**).

Next, the suspend program **123** stores the same value as that of the allocation status **2234** of the corresponding physical page **271** in the allocation status simulation **1262** for each physical page **271** in the management-side physical page management information **126** (Step S**2602**).

The suspend program **123** executes the processing of Steps S**2603** through S**2620** for each affected inter-tier page migration regarded as a suspend target, that is, for each affected inter-tier page migration for which the action is configured to "suspend". In the explanation of the tier allocation status prediction process hereinbelow, the processing-target affected inter-tier page migration will be called "target affected PM".

The suspend program **123**, for example, references data showing the migration policy stored in the memory **12**, and identifies the post-suspend migration policy of the target affected PM (Step S**2604**).

Next, the suspend program **123** references the management-side logical volume management information **127**, the management-side virtual volume management information **128**, and the management-side pool management information **129**, and identifies the virtual segment **272** (affected virtual segment) to which is allocated an affected physical page in the pool **265** (target affected pool), which is performing the target affected PM (Step S**2605**).

The suspend program **123** executes the processing of Steps S**2606** through S**2619** for each affected virtual segment identified in Step S**2605**. Hereinafter, the processing-target affected virtual segment will be called the "target affected virtual segment".

The suspend program **123** determines whether or not the post-suspend migration policy of the target affected PM is policy (b), that is, the policy for migrating data as much as possible to an accessible area of a tier **2651** at the same level as the tier **2651** allocated when the inter-tier page migration stops (Step S**2607**).

In a case where the post-stop migration policy of the target affected PM is policy (b) (Step S**2607**: YES), the stop program **123** determines whether or not there exists an unallocated physical page **271** (same tier free area), which belongs to the same tier **2651** as the affected physical page allocated to the target affected virtual segment and which is not an affected physical page (Step S**2610**). In the tier allocation status prediction process, a determination as to whether or not a physical page **271** is allocated is performed based on the value of the allocation status simulation **1262** in the management-side physical page management information **126**.

In a case where a same tier free area exists (Step S**2610**: YES), the suspend program **123** selects one same tier free area, and changes the allocation status simulation **1262** of the selected same tier free area to "allocated" for the management-side physical page management information **126** (Step S**2611**).

In a case where the post-suspend migration policy of the target affected PM is not policy (b) (Step S**2607**: NO), the suspend program **123** determines whether or not the post-suspend migration policy of the target affected PM is policy (c), that is, the policy for migrating data to an accessible area of a tier **2651** at the highest possible level than the tier **2651** allocated when the inter-tier page migration suspends (Step S**2608**).

In a case where the post-suspend migration policy of the target affected PM is policy (c) (Step S**2608**: YES), the suspend program **123** determines whether or not there exists an unallocated physical page **271** (higher-level tier free area), which belongs to a tier **2651** of a higher level than the tier **2651** to which the affected physical page allocated to the target affected virtual segment belongs and which is not the affected physical page (Step S**2612**).

In a case where a higher-level tier free area exists (Step S**2612**: YES), the suspend program **123** selects one higher-level tier free area, and changes the allocation status simulation **1262** of the selected higher-level tier free area to "allocated" for the management-side physical page management information **126**. The suspend program **123** stores the identifier of the tier **2651** to which the selected higher-level tier free area belongs in the reallocation-destination simulation determination result **1288** of the target affected virtual segment in the management-side virtual volume management information **128** (Step S**2613**).

In a case where the post-suspend migration policy of the target affected PM is not policy (c) (Step S**2608**: NO), the suspend program **123** determines whether or not the post-suspend migration policy of the target affected PM is policy (d), that is, the policy for migrating data to an accessible area of a tier **2651** at the lowest possible level than the tier **2651** allocated when the inter-tier page migration suspends (Step S**2609**).

In a case where the post-suspend migration policy of the target affected PM is policy (d) (Step S**2609**: YES), the suspend program **123** determines whether or not there exists an unallocated physical page **271** (lower-level tier free area),

which belongs to a tier **2651** of a lower level than the tier **2651** to which the affected physical page allocated to the target affected virtual segment belongs and which is not the affected physical page (Step S**2614**).

In a case where a lower-level tier free area exists (Step S**2614**: YES), the suspend program **123** selects one lower-level tier free area, and changes the allocation status simulation **1262** of the selected lower-level tier free area to "allocated" for the management-side physical page management information **126**. The suspend program **123** stores the identifier of the tier **2651** to which the selected lower-level tier free area belongs in the reallocation-destination simulation determination result **1288** of the target affected virtual segment in the management-side virtual volume management information **128** (Step S**2615**).

In a case where the post-suspend migration policy of the target affected PM is not policy (d) (Step S**2609**: NO), a case where a same tier free area does not exist (Step S**2610**: NO), a case where a higher-level tier free area does not exist (Step S**2612**: NO), or a case where a lower-level tier free area does not exist (Step S**2614**: NO), the suspend program **123** determines whether or not an unallocated physical page **271**, which is not an affected physical page (free accessible area) exists in the target affected pool (Step S**2616**).

In a case where a free accessible area exists (Step S**2616**: YES), the suspend program **123** selects one free accessible area, and changes the allocation status simulation **1262** of the selected free accessible area to "allocated" for the management-side physical page management information **126**. The suspend program **123** stores the identifier of the tier **2651** to which the selected free accessible area belongs in the reallocation-destination simulation determination result **1288** of the target affected virtual segment in the management-side virtual volume management information **128** (Step S**2617**).

Alternatively, in a case where a free accessible area does not exist (Step S**2616**: NO), the suspend program **123** notifies the administrator to the effect that a free accessible area does not exist in the target affected pool (Step S**2618**).

The suspend program **123**, after ending the execution of the processing of Steps S**2606** through S**2619** for each affected virtual segment identified in Step S**2605**, and after ending the execution of the processing of Steps S**2603** through S**2620** for each affected inter-tier page migration regarded as a suspend target, references the host management information **120** and identifies the host **3**, which accesses the virtual volume **266** associated with the target pool (Step S**2621**).

The suspend program **123** executes the processing of Steps S**2622** through S**2624** for each host **3** identified in Step S**2621**. Hereinafter, the processing-target host **3** will be called "target host".

The suspend program **123** computes the by-tier allocation rate for the target host (Step S**2623**). Specifically, the suspend program **123** references the virtual volume LBA range **1284** of the management-side virtual volume management information **128**, and computes the total capacity (hereinafter referred to as "total allocated capacity") of all the physical pages **271** allocated to the virtual volume **266** accessed by the target host. The suspend program **123** references the virtual volume LBA range **1284** and the reallocation-destination simulation determination result **1288** of the management-side virtual volume management information **128**, and computes the total capacity (hereinafter referred to as "by-tier allocated capacity") of a physical page **271**, which is allocated to the virtual volume **266** accessed by the target host and which belongs to the relevant tier **2651**, for each tier **2651** in the affected pool. For example, the by-tier allocated capacity for tier **1** is computed by totaling the capacity of the physical page **271** for which "Tier **1**" is configured in the reallocation-destination simulation determination result **1288** in the management-side virtual volume management information **128**. Thereafter, the suspend program **123** computes the percentage of the by-tier allocated capacity relative to the total allocated capacity for each tier **2651** in the affected pool. The percentage of the by-tier allocated capacity relative to the total allocated capacity computed for each tier **2651** constitutes the by-tier allocation rate for the target host.

After ending the execution of the processing of Steps S**2622** through S**2624** for each host **3** identified in Step S**2621**, the suspend program **123** ends the tier allocation status prediction process.

According to the example 3, the administrator is presented with information showing the affect on performance with respect to the host **3** when an affected inter-tier page migration is suspended, and information showing the affect on the capacity of the affected pool. This makes it possible for the administrator to check prior to stopping the storage apparatus **2** or blocking the storage area the extent to which the affected pool will be affected capacity-wise when either the storage apparatus **2** is stopped or the storage area is blocked, and to determined whether or not there is a danger of the capacity being exhausted. Then, in a case where there is a danger of the capacity being exhausted, the administrator can plan in advance for the expansion of the capacity of the affected pool.

In addition, since the administrator is able to check beforehand the by-tier allocation rate in a case where data stored in an affected physical page is migrated based on a migration policy for each migration policy of the affected inter-tier page migration, the administrator is able to examine beforehand which policy is appropriate to use as the post-suspend migration policy of the affected inter-tier page migration.

Thus, the administrator is able to check the affect on the performance of the host **3** and the affect on the capacity of the affected pool prior to suspending the affected inter-tier page migration, to examine beforehand a plan for enabling the affected inter-tier page migration to be suspended appropriately, and to formulate a plan.

It goes without saying that the present invention is not limited to the examples explained hereinabove, and that various changes can be made without departing from the gist thereof. For example, the host is not limited to a physical computer, and may be a virtual computer.

REFERENCE SIGNS LIST

1 Management computer
2 Storage apparatus
3 Host
41 SAN
42 LAN

The invention claimed is:

1. A management system for managing a computer system comprising: multiple storage apparatuses, which, upon receiving a write request for a virtual volume formed of multiple virtual segments, allocate a page to a write-destination virtual segment from a pool formed of multiple pages of multiple logical volumes and write write-target data to the allocated page; and a host computer, which sends a data write request to the virtual volume,

the management system comprising:

a storage device; and

a control device coupled to the storage device,

wherein the storage device is configured to store:

logical volume management information for managing, with respect to a logical volume in the computer system,

a corresponding relationship between a storage apparatus in which the logical volume resides and a page forming the logical volume; and

virtual volume management information for managing, with respect to the virtual volume in the computer system, the corresponding relationship between a virtual segment in the virtual volume and a page allocated to the virtual segment,

wherein the control device is configured to:

receive a selection of either a determination-target storage apparatus, which is regarded as a determination target from among the multiple storage apparatuses, or a first storage area, which is regarded as a determination target of a storage area formed of a page within a storage apparatus corresponding to the page;

identify from among either one or multiple page migrations, which are migrations of data between pages, a first page migration, which is affected by either the determination-target storage apparatus being stopped or the first storage area being blocked, based on the logical volume management information and the virtual volume management information; and

display information related to the first page migration.

2. A management system according to claim **1**,

wherein the storage device is further configured to store volume migration management information for managing, with respect to a volume migration, which is the migration of data between the logical volumes, a migration-source logical volume and a migration-destination logical volume of the relevant volume migration, and

wherein the control device is configured to:

identify, based on the logical volume management information and the volume migration management information, from among either one or multiple volume migrations a first volume migration, which is affected by either the determination-target storage apparatus being stopped or the first storage area being blocked, and

display information related to the first page migration and information related to the first volume migration.

3. A management system according to claim **2**,

wherein the control device is configured to:

receive an instruction to either set an action for the first volume migration to suspend or to resume, and a specification of a post-change migration-destination logical volume in a case where the action with respect to the first volume migration is set to resume,

do not execute the first volume migration in a case where an instruction to set the action with respect to the first volume migration to suspend has been received, and

change the migration-destination logical volume of the first volume migration which is being managed in accordance with the volume migration management information to the specified post-change migration-destination logical volume in a case where an instruction to set the action with respect to the first volume migration to resume has been received.

4. A management system according to claim **3**,

wherein the control device is configured to:

receive a specification of a migration policy, which is a policy in a case where the action with respect to the first volume migration is set to suspend, and which denotes a condition related to a migration destination, and

instruct the computer system to migrate data in the migration-source logical volume of the first volume migration to an accessible logical volume after the first volume migration suspends, and

wherein the accessible logical volume is a logical volume, which does not belong to the determination-target storage apparatus to be stopped, and is not comprised of physical pages belonging to the first storage area targeted to be blocked, and

wherein the accessible logical volume is a logical volume, which conforms to the migration policy, and in a case where a logical volume conforming to the migration policy does not exist, is a different logical volume than the logical volume, which conforms to the specified migration policy.

5. A management system according to claim **2**,

wherein the control device is configured to:

determine, upon receiving the determination-target storage apparatus selection, with respect to the volume migration performed in the computer system, whether or not either a storage apparatus in which the migration-source logical volume of the relevant volume migration exists, or a storage apparatus in which the migration-destination logical volume of the relevant volume migration exists matches the determination-target storage apparatus, and in a case where the result of the relevant determination is affirmative, identify the relevant volume migration as the first volume migration, and

determine, upon receiving the first storage area selection, with respect to the volume migration performed in the computer system, whether or not either the migration-source logical volume of the relevant volume migration exists or the migration-destination logical volume of the relevant volume migration is the logical volume formed of the page forming the first storage area, and in a case where the result of the relevant determination is affirmative, identify the relevant volume migration as the first volume migration,

wherein information related to the first volume migration comprises any one or more of information showing a policy related to the migration destination of data in the migration-source logical volume after the first volume migration has suspended, information denoting a new migration-destination logical volume for data in the migration-source logical volume after the first volume migration has suspended, information showing a host computer, which accesses the migration-source volume of the first volume migration, an expected completion date/time of a task for executing the first volume migration, and an importance of the first volume migration, and

wherein the importance of the first volume migration is based on the importance of the host computer, which accesses the migration-source volume of the first volume migration.

6. A management system according to claim **1**,

wherein the pool is a hierarchical pool in which pages are hierarchized in accordance with the page performance, and

wherein the control device is configured to:

determine, upon receiving the determination-target storage apparatus selection, with respect to the hierarchical pool for which the page migration is valid, whether or not a logical volume, which is based on the determination-target storage apparatus, is included among the logical volumes forming the relevant hierarchical pool, and in a case where the result of the relevant determination is affirmative, identify a page migration performed in the relevant hierarchical pool as the first page migration, and

determine, upon receiving the first storage area selection, with respect to the hierarchical pool for which the page

migration is valid, whether or not a logical volume formed of a page forming the first storage area is included among the logical volumes forming the relevant hierarchical pool, and in a case where the result of the relevant determination is affirmative, identify the page migration performed in the relevant hierarchical pool as the first page migration.

7. A management system according to claim **1**,

wherein the control device is configured to:

(A) set an execution of the first page migration to invalid;

(B) identify, based on the virtual volume management information, a first virtual segment to which is allocated a first page, which forms the first storage area, and which is either a page included in a logical volume, which forms the pool in which the first page migration is performed and exists in the determination-target storage apparatus, or a page of the logical volume forming the pool in which the first page migration is performed; and

(C) change the storage destination of data of the first virtual segment to an unallocated page, which is not the first page, and which is included in a logical volume forming the pool in which the first page migration is performed.

8. A management system according to claim **7**, wherein the control device is configured to decide a page in the logical volume conforming to a migration policy, which shows a condition related to a migration destination as the unallocated page in the (C).

9. A management system according to claim **8**,

wherein the control device is configured to:

execute a process for displaying information related to the first page migration,

receive an instruction to set the action for the first page migration to either suspend or resume,

execute the (A), (B), and (C) upon receiving an instruction to set the action for the first page migration to suspend, and

upon receiving an instruction to set the action for the first page migration to resume,

(D) implement control so that the first page is not allocated to a virtual segment forming the virtual volume during the implementation of the first page migration.

10. A management system according to claim **1**, wherein information related to the first page migration includes any one or more of:

(a) information showing the host computer, which accesses the virtual volume associated with the pool in which the first page migration is performed;

(b) an expected completion date/time of the first page migration;

(c) an importance of the first page migration;

(d) page usage in the pool in which the first page migration is performed prior to either stopping the determination-target storage apparatus or blocking the first storage area; and

(e) page usage in the pool in which the first page migration is performed after either stopping the determination-target storage apparatus or blocking the first storage area.

11. A management system according to claim **10**,

wherein the pool is a hierarchical pool in which pages are hierarchized in accordance with the page performance, and

wherein information related to the first page migration comprises, either instead of or in addition to any one or more of the (a) through the (e), (f) a by-tier percentage of pages of the hierarchical pool allocated to a virtual volume accessed by the relevant host computer with respect to each host computer, which accesses a virtual volume associated with the hierarchical pool in which the first page migration is performed.

12. A management system according to claim **10**, wherein the importance of the first page migration is based on the importance of the host computer, which accesses a virtual volume to which is allocated a page from the pool regarding the first page migration.

13. A management system according to claim **1**, wherein the control device is configured to display, with respect to the first page migration, information showing an affect on performance with respect to the host computer in a case where the first page migration is suspended, and information showing the affect on a capacity of the pool in which the first page migration is performed.

14. A management method of a computer system comprising: multiple storage apparatuses, which, upon receiving a write request for a virtual volume formed of multiple virtual segments, allocate a page to a write-destination virtual segment from a pool formed of multiple pages of multiple logical volumes and write write-target data to the allocated page; and a host computer, which sends a data write request to the virtual volume,

the management method comprising:

receiving a selection of either a determination-target storage apparatus, which is regarded as a determination target from among the multiple storage apparatuses, or a first storage area, which is regarded as a determination target of a storage area formed of a page within a storage apparatus corresponding to the page;

identifying a first page migration, which is affected in a case where either the determination-target storage apparatus is stopped or the first storage area is blocked, based on logical volume management information for managing, with respect to the logical volume in the computer system, a corresponding relationship between a storage apparatus in which the logical volume resides and a page forming the logical volume, and virtual volume management information for managing, with respect to the virtual volume in the computer system, the corresponding relationship between a virtual segment in the relevant virtual volume and a page allocated to the virtual segment; and

displaying information related to the first page migration.

15. A non-transitory computer-readable storage medium storing a computer program executed by a computer for managing a computer system comprising: multiple storage apparatuses, which, upon receiving a write request for a virtual volume formed of multiple virtual segments, allocate a page to a write-destination virtual segment from a pool formed of multiple pages of multiple logical volumes and write write-target data to the allocated page; and a host computer, which sends a data write request to the virtual volume,

the computer program causing the computer to:

receive a selection of either a determination-target storage apparatus, which is regarded as a determination target from among the multiple storage apparatuses, or a first storage area, which is regarded as a determination target of a storage area formed of a page within a storage apparatus corresponding to the page;

identify a first page migration, which is affected in a case where either the determination-target storage apparatus is stopped or the first storage area is blocked, based on logical volume management information for managing, with respect to the logical volume in the computer system, a corresponding relationship between a storage apparatus in which the logical volume resides and a page

forming the logical volume, and virtual volume management information for managing, with respect to the virtual volume in the computer system, the corresponding relationship between a virtual segment in the relevant virtual volume and a page allocated to the virtual segment; and

display information related to the first page migration.

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